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Functioning and design of the Central West European day-ahead flow based market coupling for electricity: Impact of TSOs Discretionary Actions

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Context

In May 2015, flow-based market coupling went live for the day-ahead market coupling in the Central West European (CWE) region. National regulators welcomed the go-live conditional to improvements to be implemented. Two years later, not all requests for improvement have been implemented and gains are below expectations.

There is a raising concern at national and European political and regulatory level on the under-utilization of the cross-border interconnection capacity, which threatens the objective of an Internal Electricity Market (IEM) with clean and affordable energy for all.

CREG is looking with other national and European political and regulatory decision makers for measures to remediate the current situation which is not only strongly affecting the CWE but also other European regions. The CREG is convinced that a European market-based solution to enforce the proper functioning of the Internal Electricity Market is more efficient than unilateral or bilateral measures.

At Central East European (CEE) and Nordic regional level, the dramatic low level of commercial capacity on interconnection lines has already been challenged in several reports. In particular, in March 2012, CEE TSOs, CEPS, MAVIR, PSE Operator and SEPS published a report on the "Bidding Zones Definition" showing the impact of unplanned flows, and the need for an adequate definition of bidding zones for the implementation of an efficient flow-based mechanism [2]. More recently, two studies published by "Swedish Energy Markets Inspectorate", the Swedish regulator, have shown that TSOs limit the interconnection capacity between the Nordic area and Germany for bottlenecks located in Germany, concluding that this is not in line with EU ambitions for a common internal market for energy [8,12].

This report provides facts-based evidence supporting the concerns raised by national regulators, ACER and numerous stakeholders, including EFET, Eurelectric, Nordenergi and the CWE Market Parties Platform, on the functioning of the IEM.

This report assesses the impact of discretionary actions taken by Transmission System Operators (TSOs) on the design and the functioning of the CWE day-ahead flow-based market coupling (DA FBMC). This study should contribute to an increased transparency on the day ahead capacity allocation process and to a better understanding by market players and decision makers of the design and the functioning of the day ahead market and of necessary evolutions to address the severe flaws of the current CWE DA FBMC implementation.

This report is structured as follows. Firstly, the relevant European Regulatory framework and the basic principles of FBMC are introduced, followed by a description and regulatory assessment of the current CWE DA FBMC design and which outlines the responsibilities of TSOs at both collective and individual level. Next, the market impact of TSO decisions is evaluated based upon the monitoring data of the first 1,5 years of CWE DA FBMC operation and upon additional studies performed by CWE TSOs and power exchanges. This evaluation reveals a major market impact of the overall design of the CWE FBMC methodology proposed by the CWE TSOs collectively. On top, discretionary actions taken by individual TSOs are found to have had a major negative market impact as well. The consequences of the observed TSO decisions are investigated and finally, remedies to address the current situation are proposed.

European regulatory framework

It is widely recognized that transmission system operation in general - and capacity calculation, capacity allocation and congestion management (CACM) in particular - plays a crucial role in a proper functioning of the IEM. The European CACM Guideline defines the combination of FBMC with

adequately defined bidding zones as a target model for achieving the objective of an IEM. With these two principal ingredients, flow-based and adequate bidding zones, congestion management can be efficient and market-based, providing correct price signals and a non-discriminatory access to the grid to domestic and cross-zonal exchanges – as outlined in Regulation (EC) No 714/2009.

CWE FBMC design

The CWE region, consisting of the borders between the Belgian, French, Dutch and German/Austrian/Luxembourg bidding zones, is the first region to have implemented FBMC for the day-ahead market coupling. While the CWE FBMC methodology, described by CWE TSOs in the Approval Package in 2015, was, as indicated in the Position paper of CWE NRAs on Flow Based Market Coupling, considered as compliant with most of the legal requirements of the European Regulatory framework, major points of non-compliance with Regulation (EC) No 714/2009 were identified. In particular, the two-step process where market coupling starts from a base case where physical flows from domestic trade have priority access to the grid, in combination with the existence of large bidding zones and the possibility to include internal network elements as network constraints, were considered as a source of noncompliance with Regulation (EC) No 714/2009 which requires that '*the maximum capacity of the interconnections and/or the transmission networks affecting cross-border flows shall be made available to market participants, complying the safety standards of secure network operation'.* Point 1.7 of Annex I of the same Regulation requires that congestion management methodologies should "*not limit interconnection capacity in order to solve congestion inside their own control area"*. CWE NRAs summarized the points to be resolved by the CWE FBMC method in a common CWE NRA Position Paper.

Given the non-compliances of the CWE FBMC methodology related to discrimination (base case and critical branches) and efficiency, CREG, in its Decision 1410, only conditionally approved the go-live of CWE FBMC under a series of conditions for further improvements of the methodology. Day-ahead FBMC went live on 22 May 2015.

The improvements to the FBMC having been required by the CREG are in line with the CACM Guideline content and timing. Nonetheless, some important requests for improvement have not yet been properly studied by CWE TSOs, let alone been implemented.

Market impact of TSO discretionary actions

The monitoring data of the first 1,5 year of CWE FBMC operation show that the threat of inefficiency and discrimination inherent to the current methodology has materialized. On top of this collective responsibility, several discretionary actions of individual TSOs seriously impact the performance of CWE FBMC as well. In this report, the impact of the following specific transmission network management related TSO decisions is analyzed:

1. The current CWE FBMC design does not properly addresses the externalities linked to the existence of large bidding zones. A first externality are the loop flows. These physical flows are included in the base case and have priority access to the grid, thereby reducing cross-zonal commercial capacities. Since the go-live of FBMC in May 2015, loop flows considered in the base case on the Belgian network were on average 900 MW in the North-South-direction. Since the go-live, price spikes above 100 €/MWh on the Belgian wholesale day ahead market only occurred in the presence of high loop flows, making electricity more expensive for Belgian consumers. In addition, the reduced Belgian import capacity in the case of high loop flows increases the needs for strategic reserve capacity (paid by Belgian consumers), as shown in the adequacy studies of Elia, the Belgian TSO. Finally, loop flows also constitute a major threat for a proper market integration of renewables since high loop flows, which have been found to be correlated with scenarios with high wind-infeed in the north of Germany, not only reduce the

import capacity of importing countries but also the export capacity of the German bidding zone, leading to very low and even negative German wholesale prices.

A second externality linked to the existence of large bidding zones is the large locational uncertainty of generation. To cope with flow forecast uncertainty, CWE TSOs introduce flow reliability margins (FRMs), lowering commercial cross-border capacity. CWE TSOs recently proposed an update of the FRMs which would increase the FRM of the Top 10 most critical lines from 12% to 16% of the thermal line capacity on average, if applied.

2. Management of internal critical lines through the FBMC mechanism has a large impact on the CWE cross-border exchange. In total, internal network constraints inside a bidding zone have limited cross-border exchanges in 33% of all considered hours, having on average not more than 19% of the thermal line capacity commercially available for cross-border exchange. Limiting cross-zonal exchange for managing congestion on highly preloaded internal lines is inefficient. This is made clear by the large shadow costs of more than 140 €/MW on average associated with these highly preloaded internal lines. In addition, the average price spread in the CWE Region is 18 €/MWh during these congested hours, with wholesale prices being the highest in Belgium and/or France and the lowest in Germany. This resulting price spread, caused by congestions on, mostly German, internal lines, leads to higher prices for French/Belgian consumers and to an unfair competitive advantage for German companies.

3. Just after the go-live of the FBMC in May 2015, Amprion, a German TSO added several internal critical branches which were not included in the parallel runs before the go-live. Those internal lines have been the most constraining network elements during the entire monitoring period, limiting cross-zonal exchange in 25% of all considered hours, with shadow costs ranging up to 9000 €/MW. The inclusion of these extra network constraints caused an increase of the Belgian, French and Dutch wholesale prices of respectively 1.4 €/MWh, 0.5 €/MWh and 0.4 €/MWh – averaged over the period July 2015 to July 2016, and a reduction of wholesale prices in the German bidding zone of 0.4€/MWh. CWE TSOs and PXs estimate that half of the potential welfare increase of FBMC compared to the formerly applied ATC was lost due to the introduction by Amprion of these additional internal critical branches. During the stressed month of November 2016, removal of those critical branches would have decreased the monthly averaged price spread between France and Germany by 4 €/MWh and increased the import by France from Germany with 1000 MW on average – an increase of import of 25%.

4. Amprion applied Flow Adjustment Values (FAVs) of +300 MW on the four interconnectors between its control area and the Dutch control area, reducing the interconnection capacity on this border by about 1200 MW. The FAVs were allowed to address exceptional situations. However, Amprion applied them for all hours over a period of 14 months. Together, these four interconnectors have limited the cross-zonal exchanges in 10% of all hours.

5. The current FBMC methodology grants total freedom to TSOs on how to adapt the thermal line capacity in function of weather conditions. Most TSOs use (at least) seasonal thermal limits, leading to higher capacities during winter (when their economic value is expected to be the highest), and have published the switching dates, but other TSOs failed to do so. Amprion, for instance, did not apply winter limits on its lines in the winter 2015 – 2016. Also in November 2016 summer limits were still applied. CWE TSO simulations for November 2016 showed that cross-zonal volumes would have been 700 MW higher on average if Amprion had applied winter limits. This increase would have mainly benefited France, with a decrease in the French – German price spread of 3.5 €/MWh on average.

6. CWE TSOs introduced explicit import and export limitations in the flow based market coupling arguing grid security reasons which cannot be captured in the DC-load flow calculation upon which the FBMC is based. During the monitoring period, all TSOs applied import limitations.

German TSOs also imposed an export limitation for the German bidding zone. These export limitations have constrained the flow based domain in 8% of the hours. To date, the CREG has not seen a sufficient justification for having a structural, static export limitation. Since the flow-based go-live, RTE has removed all external import and export limitations. In the recent proposal of CORE TSOs for the Capacity Calculation Method made in the scope of the CACM Guideline, external constraints seem also to have been removed for Germany.

7. The lack of market transparency on the network constraints introduced to the FBMC, was brought forward by market participants as one of the main reasons for distrust in the functioning of FBMC. Especially the anonymization of the names of critical network elements caused major concern since those could not be linked with the information of the planned network element outages announced on the ENTSO-E platform. While some CWE TSOs agreed to publish the physical names of the network constraints already at the go-live of FBMC, it was only from the 1th of July 2017 that all CWE TSOs agreed upon the publication of the non-anonymized data on the JAO transparency platform.

Overall, these transmission network management related TSO decisions imposed very tight constraints on the flow based market coupling and should be considered as a withholding of interconnection capacity. This is not compliant with the rules of the IEM.

In a majority of hours, the flow based domain was very small and sometimes even empty (the so-called "pre-congested case"). Last winter, up to 70% of the time, the flow based domain was not large enough to include the long-term allocated rights ("LTA-violation"). To assure these long-term rights, TSOs virtually increase the flow based domain, which is then not "flow based" but NTC based, with the available capacity of the FBMC typically amounting to 1/3rd of the old NTC-capacities for the Belgian borders. In the parallel runs which preceded the go-live of FBMC, LTA-violation was expected to occur in only 7% of the time, or ten times less.

The gains of FBMC are well below expectation. Moreover, with CWE DA FBMC, the average cross-zonal exchange volume during congested hours in 2016 was 900 MW lower than in 2013 and 2014 with ATC, a reduction close to 20%.

Consequences

The observed flaws in the design and implementation of the CWE DA FBMC have multiple consequences. The choice for a large bidding zone results in large amounts of re-dispatching, favoring old incumbents. At the same time, TSOs who limit cross-zonal trade see their re-dispatching costs or reserve capacities needs reduced. On top, with a TSO remuneration based on the regulated asset base (RAB), there is an incentive to invest in additional transmission capacity rather than to invest in an improved utilization of the existing capacity. The current CWE DA FBMC allows to have an inefficient utilization of the existing grid and so facilitates the justification for additional transmission capacity. Finally, for exporting countries, a reduction of cross-zonal exchanges keeps wholesale electricity prices low which in turn favours the national industry.

It is clear that the inefficient and discriminatory implementation of FBMC in CWE and the consequent discretionary actions of some TSOs show strong similarities with the so-called "Swedish Case". In that case, the European Commission raised competition concerns based on the observation that Svenska Kraftnät (SvK), the Swedish TSO, was curtailing interconnector capacity because of internal congestion problems. The Commission judged that, by doing so*, "SvK was treating domestic transmission services and transmission services to an interconnector intended for exporting electricity, differently, thereby impeding customers and producers from reaping the benefits of the IEM"*. To address these concerns, SvK decided in September 2009 to subdivide the Swedish bidding zone into two or more bidding zones and to manage congestion in the Swedish transmission system without limiting trading capacity on the interconnectors.

Remedies

CREG is looking with other national and European political and regulatory decision makers for short and long-term measures to remediate the current situation which is not only strongly affecting the CWE region but also other European regions.

One could argue that Belgium could solve at least the problem of large loop flows by using its four Phase Shifting Transformers (PSTs) situated close to the border with the Netherlands, to "push back" these loop flows. However, from an analysis by Elia of November 2016, decreasing loop flows with its PSTs would complicate the situation in other parts of the CWE bidding zone if highly preloaded internal transmission lines are kept as critical network elements in the FBMC, the latter being challenged by CREG. So far, CREG has not asked Elia to limit loop flows on its borders with its PSTs.

The CREG is still convinced that a European solution to enforce the proper functioning of the Internal Electricity Market is more efficient than unilateral measures.

According to CREG, an enduring and efficient solution to the observed inefficiencies, discrimination and unfair competition can only be found in the full implementation of the CACM Guideline, with adequate, meaning sufficiently small, bidding zones or through the move to a nodal design, which allows a full utilisation of transmission network capacities.

A proper bidding zone configuration (combined with multi-zonal hubs) will overcome the severe flaws in the current CWE DA FBMC design and discretionary actions taken by individual TSOs and will contribute to a drastic and structural reduction of re-dispatching and reserve capacities. This will reduce the level of unscheduled flows and associated uncertainty and thus increase both the level of commercially available capacity and system security.

In awaiting this structural solution of adequate bidding zones or if German decision makers keep opposing this solution, the externalities caused by the current bidding zone configuration and the discrimination of cross-border exchange in favour of domestic trade caused by the current CWE FBMC design have to be adequately addressed.

To this end, in November 2016, ACER has published its *Recommendation on the common capacity calculation and re-dispatching and countertrading cost sharing methodologies* recommending a drastic reduction of loop-flows, an interdiction of critical branches internal to a bidding zone and the adoption of the polluters pay principle for the allocation of re-dispatching costs. As a way to implement this recommendation, CREG proposed in March 2017 a revision of the Critical Branch Critical Outage (CBCO) selection method with minimal Remaining Available Margin (RAM) requirements on all network elements managed through Flow Based Market Coupling. This proposal is attached as annex to this study.

Adequately defined bidding zones will automatically lead to sufficiently high RAM on the constraining network elements and, hence, will comply with IEM. It is possible to implement a so-called "technical zone splitting", where one national price zone is kept for consumers combined with several bidding zones for producers. However, the CREG has the impression, through informal contacts, that this solution has not been studied in detail by German decision makers.

If the German bidding zone is not split, having sufficiently high RAM on its constraining network elements in order to comply with the rules of the IEM will require large re-dispatching reserves and costs. The CREG doubts that re-dispatching can be sufficient in this regard. Moreover, large and frequent re-dispatching could in itself lead to inefficiencies, discrimination and unfair competition.

Whatever the outcome of the bidding zone review may be, it should be clear for everyone involved that it is impossible to comply with the rules of the Internal Electricity Market, if the CBCO-selection method allows low RAM requirements, as is the case today.

In close cooperation with all stakeholders involved, CREG will make all efforts to contribute to the achievement of an enduring solution for an efficient organization of the electricity markets, convinced of their vital role in making the energy transition towards secure and sustainable energy provision to happen.

The functioning of CWE DA FBMC was on the agenda of a high-level CWE NRA meeting, held in Paris in November this year, followed by a CWE NRA meeting with DG Energy in December. CWE national regulators are negotiating upon short and medium term measures to remediate the current situation. If the measures, proposed by CREG and other NRAs, will be implemented, CREG expects a significant improvement.

The present Study was approved by the CREG's Executive Committee during its session of 21 December 2017.

1. CONTEXT

TSOs play a crucial role in reaching the objective of an efficient Internal Electricity Market (IEM) with clean and affordable energy for all. The design and the operation of day-ahead congestion management, including the calculation and the allocation of cross-zonal transmission capacities, are key components for reaching this objective. Indeed, the efficient use of the existing transmission network is of vital importance to reach the objective of the IEM.

At a European level, this target is yet far for being reached with less than 50% of the commercial interconnection capacity effectively being used for cross-zonal trade as indicated in the latest ACER Market Monitoring Report. This under-utilisation of the European transmission network infrastructure limits cross-border exchanges, limits price convergence between the bidding zones and hampers the market-integration of renewables. This under-utilization of the grid is a source of increasing concern at both national and European regulatory level since it finds its basis in practices violating the principles of efficiency, fair competition and non-discrimination on which the IEM is based.

At Central East European (CEE) and Nordic regional level, the dramatic low level of commercial capacity on interconnection lines has already been challenged in several reports. In particular, in March 2012, CEE TSOs, CEPS, MAVIR, PSE Operator and SEPS published a report on the "Bidding Zones Definition" showing the impact of unplanned flows, and the need for an adequate definition of bidding zones for the implementation of an efficient flow-based mechanism [2]. More recently, two studies published by "Swedish Energy Markets Inspectorate", the Swedish regulator, have shown that TSOs limit the interconnection capacity between the Nordic area and Germany for bottlenecks located in Germany, concluding that this is not in line with EU ambitions for a common internal market for energy [8,12].

At a Central West European level, this target is not yet reached neither, as indicated in the latest CREG Market Monitoring report. This might come at a surprise, since the CWE region, consisting of the borders between Belgium, the Netherlands, France and the German bidding zone, was the first European region to launch Flow-Based Market Coupling (FBMC) for the day-ahead (DA) market coupling in May 2015. FBMC should outperform the former ATC-method thanks to an optimization-based allocation of the available commercial interconnection capacity. "Optimization" is to be understood as maximizing the social welfare in the CWE region, taking the network constraints into account. Those network constraints depend, amongst others, on the grid topology and on safety measures taken by TSOs. They are included as input parameters to the FBMC algorithm by the different TSOs of the CWE region.

The monitoring showed that the gains of CWE DA FBMC are well below expectations. On the contrary, with FBMC, the average cross-zonal exchange volume during congested hours in 2016 was significantly lower than before. On top, price volatility on the Belgian wholesale power market increased, especially in the months October and November 2016. Prices on the Belgian day-ahead market (DAM) were amongst the highest observed in the Central-West European (CWE) region with an increased occurrence of price spikes. At the same time, total CWE cross-border exchanged volumes fell sharply. In October 2016, when prices on both French and Belgian DAM surged, the combined import capacity was limited to 3400 MW, on average.

It was found that collective and individual TSO decisions have led to very tight constraints on the CWE DA FBMC, a situation being not compliant with the rules of the IEM. This observation has lead national energy regulators and numerous stakeholders, including ACER, EFET, Eurelectric, Nordenergi and the CWE Market Parties Platform, to formally and explicitly express their concerns with the current situation, urging TSOs to improve the methodologies for cross-border capacity management. This study provides facts-based evidence supporting these concerns. The aim of this study is to assess the market impact of collective and individual TSO decisions and actions on the CWE FBMC performance,

based on the first 1,5 year of CWE DA FBMC monitoring data and additional simulation studies performed by TSOs and power exchanges.

This study aims at contributing to an increased transparency on the day ahead capacity allocation process and at providing market players and decision makers insight in the functioning of the CWE DA FBMC and of necessary evolutions of its current implementation. The study is structured as follows.

Chapter 2 provides the European regulatory framework for congestion management, the principles of a flow-based market coupling together with its motivation, and the design of the CWE day-ahead Flow Based Market Coupling implementation as it is operational today. Finally, the major concerns of the CWE national regulatory authorities (NRAs) collectively and as formulated in CREG decision 1410 on the proposal made by the CWE TSOs in 2015 are summarized.

Chapter 3 highlights the impact of the collective and individual TSO actions on the functioning of the CWE FB MC since the go-live in May 2015.

Chapter 4 discusses the consequences of limiting cross-border trade in favor of domestic trade, from a TSOs perspective.

Chapter 5, finally, summarizes short and long-term measures for addressing the observed discriminations.

2. EUROPEAN LEGAL CONTEXT FOR CONGESTION MANAGEMENT, FLOW BASED MARKET COUPLING PRINCIPLES AND ITS IMPLEMENTATION

This chapter presents the most relevant principles of congestion management and of a flow-based calculation with an implicit allocation of transmission capacities and describes how these are translated in the design of the CWE flow based market coupling.

2.1. EUROPEAN LEGAL CONTEXT FOR CONGESTION MANAGEMENT

The current Capacity Allocation and Congestion Management target model, as described in the CACM Guideline 2015/1222, is based, for the day-ahead (and intraday) time frame, on a flow-based calculation and an implicit allocation of transmission capacities combined with adequately defined bidding zones based on efficiency.

This CACM Guideline 2015/1222 is a more formalised translation of rules already present in the Regulation 1228/2003 and its Annex amended through a Commission Decision of the 9 November 2006 and published in the Official Journal of the European Union the 11th of November 2006 with the reference 2006/770/EC. This Annex, named "Guidelines on the management and allocation of available transfer capacity of interconnections between national systems", and its Article 1.7 (still valid today as attached to regulation 714/2009) indicated for the first time that congestions may not be pushed at the border and that the TSOs must define the appropriate network areas in and between which congestion management is to be applied (this has been translated today in Entso-E's bidding zones review process).

<u>Regulation (EC) No 714/2009</u>

Regulation (EC) No 714/2009 establishes general rules for congestion management. These rules are based on general European competition principles, which foster the formation of a free market and price signals, and consequently provide incentives for investment in production and transmission infrastructure.

In particular, Article 16(1) of Regulation (EC) No 714/2009 stipulates that 'network congestion problems shall be addressed with non-discriminatory market-based solutions which give efficient economic signals to the market participants and transmission system operators involved.'

Article 16(3) of the same regulation provides for an obligation to maximize interconnection capacity, requiring that 'the maximum capacity of the interconnections and/or the transmission networks affecting cross-border flows shall be made available to market participants, complying the safety standards of secure network operation'.

This principle is complemented by point 1.7 of Annex I of the same Regulation, which provides that 'When defining appropriate network areas in and between which congestion management is to apply, TSOs shall be guided by the principles of cost-effectiveness and minimisation of negative impacts on the internal market in electricity' which set on the TSOs the responsibility of the definition of adequate bidding zones and provides indications on how this definition of bidding zones should be made: 'TSOs shall not limit interconnection capacity in order to solve congestion inside their own control area, save for the abovementioned reasons [i.e. cost effectiveness and minimization of negative impacts on the internal market in electricity] and reasons of operational security'.

These rules indicate that congestion management problems should be solved with an efficient market based allocation of scarce capacity, providing this scarce capacity to those requests for transport which have the highest value (market based approach).

The EU target model for congestion management is based on the assumption that bidding zones, geographical areas within which market participants are able to exchange energy without capacity allocation, corresponds to copper plates which supposes that:

- Each bidding zone has an unlimited internal transmission capacity, and congestions appear only on the borders or between bidding zones and there is no congestion inside bidding zones;

- Each bidding zone has zero internal impedance, and exchanges internal to a bidding zones do not create loop flows outside the bidding zone through other bidding zones.

It should be understood that Regulation (EC) No 714/2009 does not forbid the (exceptional) occurrence of a congestion inside a bidding zone. Rather, this regulation indicates that the cross-zonal congestion management mechanism cannot be used to manage structural congestions inside a bidding zone, which have to be tackled differently (through local re-dispatching) because the use of the cross-zonal mechanism for solving internal congestion corresponds to "pushing that congestion to the zone border" and results in a decrease of cross-zonal trade, which is inefficient and discriminatory.

ACER Recommendation made in November 2016 on the common capacity calculation and re-dispatching and countertrading cost sharing methodologies (published on ACER website) provides some insight on how to understand this Regulation 714 and in particular the Article 1.7 of its Annex 1.

<u>Specific rules pursuant to the CACM Regulation</u>

The general congestion management rules of Regulation (EC) No 714/2009 are supplemented by the CACM Regulation. As far as the common methodologies on capacity calculation and congestion management are concerned, specific requirements arise in particular from Articles 3, 17, 18, 21, 22, 23, 24, 25, 32, 33, 35 and 74.

The current Capacity Allocation and Congestion Management target model, described in the CACM Guideline 2015/1222, is based, for the day-ahead (and intraday) time frame, on a flow-based calculation and an implicit allocation of transmission capacities combined with adequately defined bidding zones based on efficiency.

In particular, as an important input for this study, Article 21(1)(b)(ii) of CACM Regulation on the capacity calculation methodology stipulates that the common capacity calculation methodologies should include "rules for avoiding undue discrimination between internal and cross-zonal exchanges to ensure compliance with point 1.7 of Annex I to Regulation (EC) No 714/2009". The same reference is made in Article 18 on the development of scenarios for the common grid model.

The history of these capacity allocation and congestion management rules as outlined above, with reference to Articles and Annex of an old Regulation 1228/2003 amended in 2006, shows the stability and the consistency of the legal framework applicable on TSOs for congestion management.

2.2. ZONAL FLOW BASED MARKET COUPLING

2.2.1. Motivation

The European Target Model prescribes the implementation of a FBMC because it is potentially more efficient than the ATC methods which was used in the CWE region until May 2015 and which is still used on most European borders. The implementation of FBMC on other European borders is under development (e.g. in Core region, or in the Nordic region) or under investigation.

Commercial use of interconnection capacity comprises two key elements: capacity calculation and capacity allocation. Capacity calculation defines transmission margins available for commercial exchanges. This is considered as a core task of transmission system operators. Capacity allocation defines how this capacity is sold to and used by the market taking into account network constraints and efficiency parameters (the PTDFs) and is currently, in the CACM framework, a task to be realized by the MCO function resulting from a collaboration between NEMOs.

The ATC-method entails significant conservatism. The main reason is that at the stage of determining the available commercial capacity on a specific border, the set of commercial exchanges on the other borders is not known yet. This matters for capacity calculation. Commercial exchanges give rise to physical flows which make use of the entire network, following the path of least resistance (Kirchhoff's laws). These physical flows can decrease the capacity for commercial exchange in one direction, and increase it in the opposite direction. Therefore, one cannot simply say that the physical capacity (the total thermal capacity) of an interconnection line between two adjacent markets is the capacity available for commercial exchanges. One needs to take into account the physical impact on the network of all commercial exchanges taking place at the same time. For grid security reasons, the commercial capacity given to the market by TSOs with ATC equals the smallest capacity resulting from all possible sets of exchanges.

With FBMC, by contrast, the set of commercial exchanges between the different bidding zones are defined (and optimized) simultaneously, taking into account the impact of the commercial exchanges on the total social welfare on the one hand, and on the physical use of the network on the other. Compared to ATC, Flow Based Market Coupling reduces the uncertainty related to the commercial exchanges between zones and makes it possible to create synergies through combinations of exchanges. This way, a less conservative and a more effective usage of the existing transmission network capacity can be achieved.

The use of FBMC for optimizing cross-zonal trade removes the uncertainty on the physical flows related to commercial exchanges on the CWE cross-zonal borders. The uncertainty on the physical flows related to commercial exchanges within the zones, i.e. domestic flows and loop flows, however, is still present. This uncertainty is inherent to the choice for a zonal market design in the European target mode and depends for a large extent of the size of the bidding zone. With a nodal market design, by contrast, there are no 'internal exchanges': all commercial exchanges between any pair of nodes is made explicit, and thus also the physical impact on the network. This way, the set of all commercial exchanges can be optimized simultaneously and all network constraints can be taken into account. The zonal market design can theoretically approach the effectiveness of the nodal one by having smaller and appropriately defined bidding zones with only residual internal congestions such that the copper-plate assumption holds. Such an adequate zonal configuration is a prerequisite for achieving an efficient, market-based, non-discriminating and secure grid management.

2.2.2. Basic concepts

This section presents the basic concepts of FBMC. The description focuses on how FBMC deals with network constraints and highlights the role and responsibility of TSOs in determining the model inputs for handling these network constraints.

The flow based allocation mechanism maximises the welfare of exchanges in and between bidding zones, taking into account the limitations imposed by critical network elements of the transmission system in normal conditions (N state) and in outage conditions (N-1 situation where one element of the transmission system is missing). In the Central West European (CWE) Flow Based Market Coupling (FBMC), these critical network elements limiting the flow-based domain in N-1 situation are referred as Critical Branch - Critical Outage (CBCO).

The output of the FBMC optimization is the set of zonal Net Exchange Positions (NEP) and corresponding market clearing prices. The flows resulting of the set of NEP must respect all network constraints, assuring that cross-border trade does not cause a thermal overload on any of the critical branches. In other words, the physical flows induced on that line for a given set of NEP, defined by the Power Transfer Distribution Factors (PTDF), must be lower than the commercially available capacity or Remaining Available Margin (RAM, in MW).

The aim of the optimization is to find the combination of NEP which maximizes social welfare under the given network constraints:

Max(Social Welfare(NEP))

Sum(PTDF*NEP) < RAM for all CBCO in the CBCO-set [Eq.1]

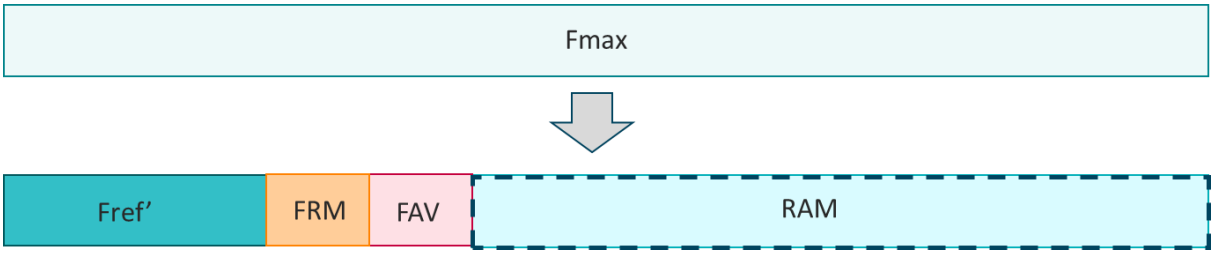
The network constraints [Eq.1] define the so-called flow-based domain.

For each CBCO, the following relation applies:

RAM = Fmax – Fref' – FRM - FAV [Eq.2]

Fref' = Fref + (LTN – RefProg) * PTDFzone-to-zone [Eq.3]

The RAM represents the margin available for cross zonal trade, Fmax the thermal limit of the transmission line, Fref' the flows present on the transmission line at the start of the day-ahead allocation process (with the nomination of long-term rights - LTN), FRM an additional security margin, NEP the total net export (export = positives values) position of a given bidding zone (MW) and FAV a flow adjustment value which may increase (if negative) or decrease the capacity available on a network element corresponding to the implementation of some remedial actions or to (exceptional) actions which may be taken by the TSOs to ensure the security of the system. The PTDF in this formula is a zone to zone PTDF.



Fref' (MW) is the physical load on the lines at the start of FBMC, i.e. before day-ahead cross-border market coupling (all day-ahead NEP still Zero). Fref' is calculated from the reference flows (Fref) in the common base case by subtracting the physical flows resulting from to the NEP of the base case (RefProg, in MW) and of the long-term nominations (LTN).

A set of zonal Power Transfer Distribution Factors ($PTDF_{zone\text{-}to\text{-}zone}$) makes the link between the cross-zonal exchanges and the physical flows on a given critical branch. They are calculated from the nodal PTDF-matrix, which describes the entire CWE transmission network (through a DC load flow approximation) and the GSK-matrix, which describes the estimated change of the nodal distribution of the electricity generation within a bidding zone as a response to a change in zonal NEP.

$PTDF_{zone\text{-}to\text{-}hub} = PTDF_{node\text{-}to\text{-}hub} * GSK$ [Eq.4]

Very often, in order to facilitate their determination, PTDF are expressed as the impact of a power transfer between a given location (zone, node) and a hub taken as reference.

Figure 1 below illustrates the concept of FBMC for a fictional case with 3 bidding zones: zone A, zone B and zone C. Because all NEP must sum up to zero (NEP A + NEP B + NEP C = 0), there are only 2 independent NEP, e.g. NEP A and NEP B. Three cases are depicted: a copper plate case, an uncongested case and a congested case. A fourth case, namely LTA-violation (a special case of the congested case) is shown in Figure 4.

The axis of this figure represents the (independent) net position of zone A and zone B of this 3 zones example. A critical branch critical outage (CBCO) separates the feasibility domain in two parts: a feasible region and an unfeasible one, leading to overload on that CBCO (N or N-1 condition). A set of critical branches defines an internal domain which represent the area of feasible combinations of exchanges between bidding zones.

The three cases in Figure 1 show the market outcome in function of the network constraints:

- In the copper plate case, there are no network constraints. The maximum of the social welfare function defines the optimal combination of NEPs. There is full price convergence.
- In the uncongested case, the maximum of the social welfare function lies inside the flow based domain, and the market can clear at that point. There is full price convergence.
- In the congested case, the maximum of the social welfare function lies outside the flow based domain. The market cannot clear at that point without violating one or more network constraints. The market therefore clears on the edge of the domain and hits one or more network constraints. These are the active constraints ('active CBCOs'). There is no full price convergence. Since the social welfare could have been higher without this CBCO, there is an opportunity cost or 'shadow price' associated with this active CBCO. The shadow price (expressed in €/MW) is the marginal increase of the social welfare (in €) for a marginal increase in the capacity of that constraint (in MW).

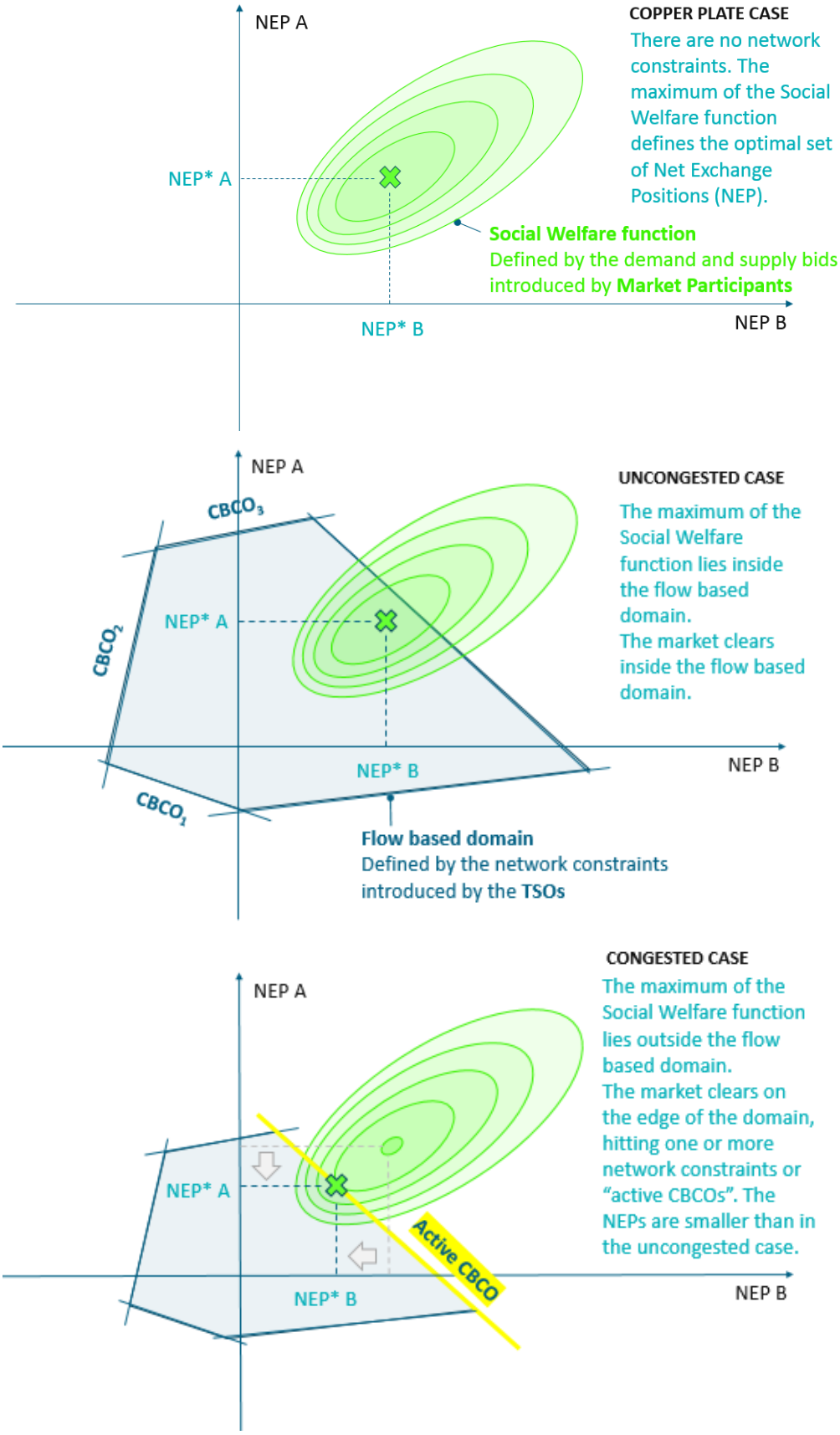


Figure 1: Illustration of the impact of network constraints on the market outcome with a Flow Based Market Coupling for a fictional example with 3 bidding zones A, B and C. The market outcome depends on the shape and location of the social welfare function (green) and on the size and shape of the flow based domain defined by the network constraints (blue). Three cases are shown: the cupper plate case (top), the uncongested case (middle) and congested case (bottom). Source: CREG

In each case, the inputs from market participants are assumed to be the same, so identical demand and supply bids. Therefore, the social welfare function which defines the value of all (internal and cross-zonal) exchanges, is unaltered. In the graphs, the social welfare function is assumed to be a nicely convex 'hill' with the altitude lines shown as ellipses. The 'top' indicates the combination on net exchange positions maximizing social welfare.

Above, it was shown that the market outcome depends on the flow-based domain which's size and shape changes hour by hour depending on the set of CBCOs [Eq.1]. The more capacity available on these CBCOs, the larger the flow based domain as explained hereafter.

A CBCO, characterized by its set of PTDF-values (one for each bidding zone) and its RAM, imposes the following constraint to the combination of Net Exchange Positions:

$$PTDF_{A,C}\ NEP_A + PTDF_{B,C}\ NEP_B \leq RAM \text{ [Eq.4]}$$ [1]

The impact of the PTDFs and the RAM in [Eq.4] is illustrated in figures 2 and 3 below by two fictional cases: in the first case, $CBCO_1$ limits the flow-based domain in the upper right corner and in the second case $CBCO_2$ limits the domain in the lower left one.

In the first case, illustrated in Figure 2, the market wants to clear in the right upper corner of the flow-based domain. Zone A and zone B are both willing to export to zone C:

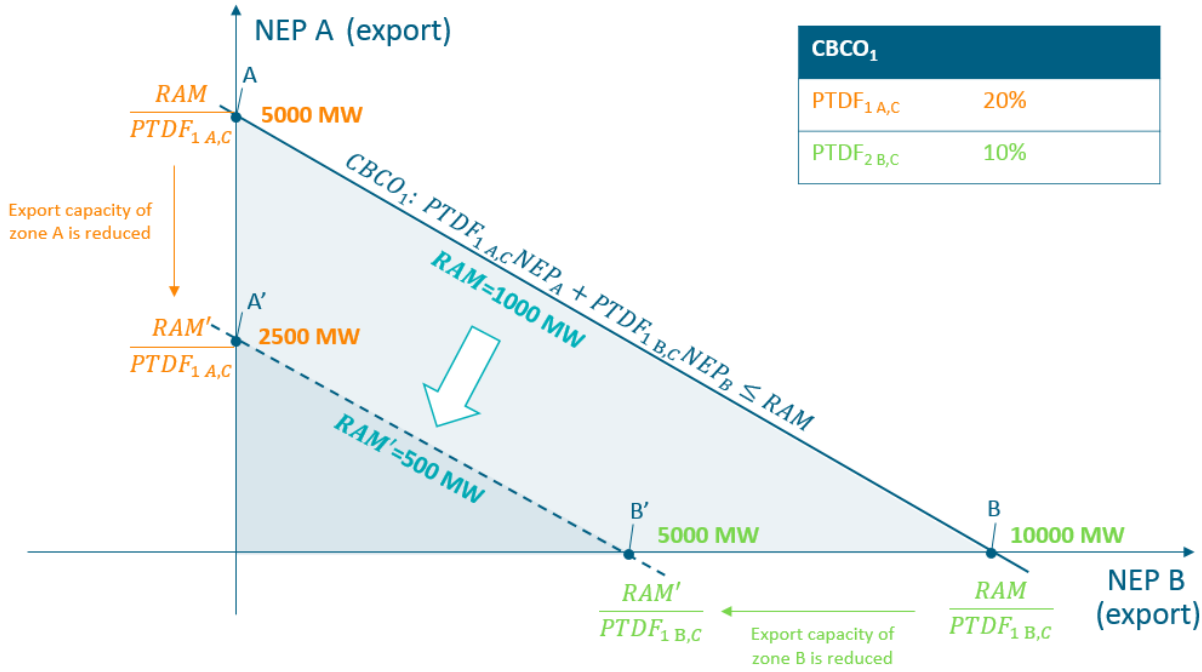
$$NEP_A \geq 0,\ NEP_B \geq 0 \text{ and } NEP_C \leq 0$$

It is assumed that the physical flows on $CBCO_1$ resulting from a commercial exchange from zone A to zone C (represented by $PTDF_1$ A,C) and those resulting from a commercial exchange from zone B to zone C (represented by $PTDF_1$ B,C) flow in the same direction and thus add up. $PTDF_1$ A,C and $PTDF_1$ B,C then have the same sign. In this example $PTDF_1$ A,C is equal to +20% and $PTDF_1$ B,C is equal to +10%.

If $CBCO_1$ has a RAM of 1000 MW, it follows from Eq.10 that zone A can in theory maximally export 1000/0.20 = 5000 MW to zone C. This market result is shown as point A in Figure 2. Zone C will import 5000 MW and zone B will have a zero net position. If the market prefers to export from zone B to zone C, then $CBCO_1$ limits the export position of zone B to 1000/0.10 = 10000 MW. Zone C will import 10000 MW from zone B and zone A will have zero net position, shown as point B.

If the RAM on $CBCO_1$ drops to 500 MW, it can be derived that zone A can now only export 2500 MW (market clears at point A' of Figure 2 and zone B can maximally export 5000 MW (market clears at point B') to zone C. The size of the flow based domain decreases. The decrease of feasible trade is larger than the decrease of the RAM: a drop of 500 MW of the RAM on $CBCO_1$, characterized by the given set of PTDFs, yields a decrease of the maximum export position of 2500 MW and 5000 MW from respectively zone A and zone B. The impact of a RAM reduction is thus magnified at the level of cross-border exchange. The smaller the PTDF, the larger this multiplication effect.

[1] This equation can be derived from the more general equation $PTDF_{A,h}\ NEP_A + PTDF_{B,h}\ NEP_B + PTDF_{C,h}\ NEP_C \leq RAM$ [Eq.4] by substituting NEP_C by $NEP_C = -(NEP_A + NEP_B)$ and by substituting the zone-to-hub PTDFs by the zone-to-zone PTDFs: $PTDF_{A,C} = PTDF_{A,h}$ - $PTDF_{C,h}$ and $PTDF_{B,C} = PTDF_{B,h}$ - $PTDF_{C,h}$



$CBCO_1$	
$PTDF_{1\ A,C}$	20%
$PTDF_{2\ B,C}$	10%

CBCO 1		Max Export A	Max Export B
RAM	1000 MW	5000 MW	10000 MW
RAM'	500 MW	2500 MW	5000 MW
Delta	**- 500 MW**	**-2500 MW**	**-5000 MW**

Figure 2: The critical branch – critical outage $CBCO_1$ limits the flow based domain in the right upper corner when zone A and/or zone B export to zone C.

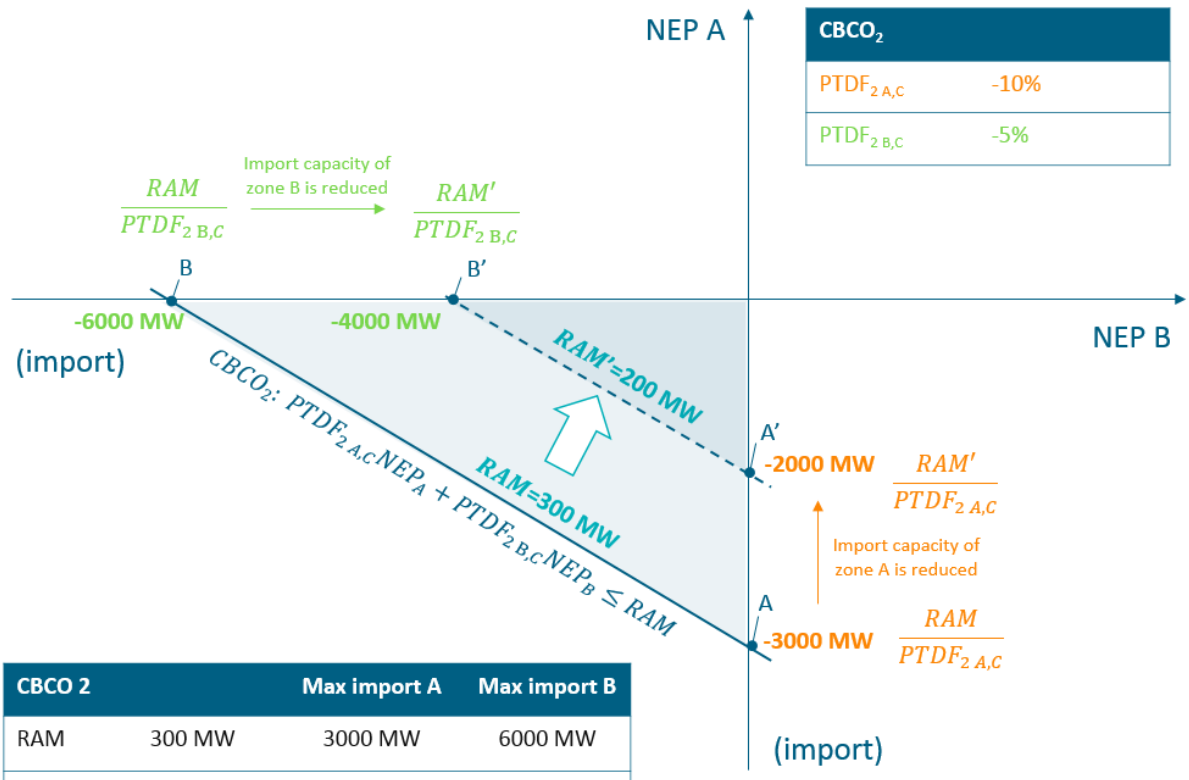
In the second case, illustrated in Figure 3, the market wants to clear in the left lower corner of the flow-based domain. Zone A and zone B are both willing to import from zone C:

$$NEP_A \leq 0,\ NEP_B \leq 0 \text{ and } NEP_C \geq 0$$

Consider a second critical branch critical outage, CBCO2, with $PTDF_2$ A,C = -10% and $PTDF_2$B,C= -5%[2]. If the RAM on CBCO2 is 300 MW, it follows from Eq.10 that zone A can maximally import 300/-0.10 = -3000 MW from zone C with zone B having a zero net position. This market result is shown as point A in Figure 3. If the market prefers to import from zone B, then CBCO2 limits the import position of zone B to 300/-0.05 = -6000 MW from zone C and zone A having zero net position. This point is shown as point B.

If the RAM on CBCO2 drops to 200 MW, Eq.10 shows that zone A can maximally import 2000 MW (market clears at point A', Figure 3) and zone B can maximally import 4000 MW (market clears at point B'). Again, the impact of the RAM reduction on CBCO2 is magnified at the cross-border exchange level and leads to a substantial decrease of the flow based domain. Because the PTDFs are smaller than in the previous example, the multiplication effect is even larger: all other things being equal, a 100 MW RAM reduction decreases the import capacity of zone A from zone C by 1000 MW (= ΔRAM/$PTDF_2$ A,C) and decreases the import capacity of zone B from zone C by 2000 MW (=ΔRAM/$PTDF_2$ B,C).

[2] PTDF A,C and PTDF B,C of $CBCO_2$ are negative since $CBCO_2$ limits the flow based domain when $NEP_A \leq 0$ and/or $NEP_B \leq 0$. A negative PTDF A,C indicates that a commercial exchange from A to C (A exports) reduces the line loading and thus frees up capacity. Inversely, a commercial exchange from C to A (A imports) increases the line loading and thus consumes capacity.



CBCO 2		Max import A	Max import B
RAM	300 MW	3000 MW	6000 MW
RAM'	200 MW	2000 MW	4000 MW
Delta	**-100 MW**	**-1000 MW**	**-2000 MW**

Figure 3: The critical branch – critical outage $CBCO_2$ limits the flow based domain in the left lower corner when zone A and/or zone B import from zone C.

The above description of FBMC highlight the importance of the network constraints on the final outcome, i.e. the zonal Net Export Positions by introducing the so-called 'Flow Based parameters' such as the RAM and the PTDF and shows how these parameters depend on the inputs provided by TSOs, the FRM and the FAV. As explained in the next two sections, TSOs have a substantial degree of autonomy in determining these 'Flow Based parameters' and – as a consequence – TSOs have a large impact on the FBMC outcome.

2.3. CWE FLOW BASED MARKET COUPLING IMPLEMENTATION

This section describes the design choices made by CWE TSOs for the implementation of the FBMC in the CWE region. The focus is on the parameters and elements which are determined by the TSOs and which are considered to have a significant impact on the FBMC performance (See Chapter 3).

For a more elaborate description of the flow based parameters, reference is made to the CWE FBMC Approval Package [4] and CREG Decision [5]. A concise, theoretical view on the impact of flow based design choices can be found in Marien and al. [3].

2.3.1. Bidding zone configuration

The delineation of the bidding zones in the CWE region is largely based on the national borders of participating countries. The CWE Region currently consists of four bidding zones: the Belgian (BE), Dutch (NL), French (FR) and German/Austrian/Luxembourg (DE/AT/LU) bidding zones. The size of the

bidding zones is thus very mixed: bidding zones FR and DE/AT/LU are much larger than the ones of BE and NL.

The question of the adequacy of the existing bidding zone configuration has been raised for more than 10 years today, through a combination of legal requirements and NRAs positions, but no more adequate bidding zone configuration has been proposed by the TSOs so far and taken into account in the design of the CWE FB market coupling.

2.3.2. Establishment of a zero-balanced base case and determination of Fref'

The zero-balanced base case Fref is the starting point for the day-ahead flow based market coupling. It defines the line loading before any day-ahead cross-border trade has taken place, i.e. when all day-ahead NEP in the CWE-region are zero. Fref is elaborated on the basis of a snapshot of observed flows and exchanges arising in a situation (D-2 very often) which should be as close as possible to the situation expected for day D.

Fref' is the netted physical flow resulting from the following commercial exchanges:

- domestic trade inside a bidding zone, leading to domestic flows inside the bidding zone and loop-flow outside the bidding zone,
- nominations of long-term transmission rights leading to "long-term transit flows".

Today, with the current bidding zone configuration and the current low values of long-term rights (only those of the type Physical Transmission Rights (PTR) are taken into account), Fref' mainly arises from domestic trade. In large bidding zones, Fref' mainly originates from domestic flows while in small bidding zones, loop flows have a relatively larger impact (See also Section 3.2).

Fref' flows have priority access to the grid. Only the leftover capacity can be used for cross-zonal market coupling (see definition of RAM in Section 2.2.2**Error! Reference source not found.**). No s olutions to the discrimination issue was examined seriously in the CWE region, especially within the frame of the determination of the Fref, and the answer to discrimination issues was supposed to be tackled by the "to be realised" bidding zones reviews.

2.3.3. Transmission line capacity (Fmax)

Fmax is the estimated maximum transmission capacity of a CB. The maximum line capacity or 'thermal line capacity' depends on the weather conditions. Lower ambient air temperatures and higher wind speed, for instance, tend to increase the cooling rate of the lines and thus the maximum power which can be transmitted. Ideally, Fmax should therefore be updated on an hourly basis depending on e.g. temperature forecasts.

The CWE FBMC Approval package submitted by the TSOs leaves the choice to define Fmax to the individual TSOs, though suggests to at least apply seasonal ratings. Until now, this is the approach adopted by most TSOs. Some TSOs are now experimenting Dynamic Line Rating (DLR) to update values closer to real-time, while some TSOs keep Fmax constant throughout the year (see Section 3.5).

2.3.4. Flow Reliability Margins (FRM)

Flow Reliability Margins (FRM) are security margins taken into account on critical branches to cope with uncertainties on the flows expected on these network elements. These uncertainties result from all unexpected events occurring between the determination of the FB parameters two days ahead and

the real time and on the lack of locational information inherent to a zonal design. These events may be, amongst others, changes in the generation and consumption patterns or changes of exchanges on non-CWE borders. Flow reliability margins are taken on each critical branch, in addition to the N-1 security criteria already taken into account in the capacity calculation method. The average value of the FRM of all critical branches corresponding to the approval package was equal to 12% of the total FMAX capacity of the critical branches.

2.3.5. Final Adjustment Values (FAV)

In the current implementation of the CWE FB MC, the tripping of a transmission line (or more generally any N-1 constraint) is explicitly taken into account in the optimisation process. Remedial actions (such as network topology measures including the setting of Phase Shift Transformers (PST) may also be explicitly taken into account in the Flow Based parameters of the CBs for these N-1 situations.

Nevertheless, some complex remedial action can only be taken into account through an implicit, indirect way by the use of a negative Final Adjustment Value (FAV) parameter which allows an increase of the RAM.

In the approval package, negative and positive FAV are indicated. Occurrences of positives values are presented as a consequence of the local verification phase of the FB domain, leading to the need to reduce the margin on one or more CBs for system security reasons. The overload detected on a CB during the verification phase is the value which will be put as FAV for this CB in order to eliminate the risk of overload on that CB. Any usage of positive FAV is supposed to be exceptional, duly elaborated and reported to the NRAs for monitoring.

2.3.6. Zonal Power Transfer Distribution Factor (zonal PTDF)

A zone-to-zone PTDF defines the physical flow on a transmission line resulting from a unit cross-zonal power exchange between the two bidding zones, expressed in MW/MW. A zone-to-zone PTDF of 5% on a critical branch for an exchange between Belgium and the Netherlands, for instance, means that the physical flow on that CBCO is estimated to 50 MW for a 1000 MW commercial exchange between Belgium and the Netherlands.

In a zonal FBMC, each transmission line is characterized by a set of zonal Power Transfer Distribution Factors (PTDFs), one for each zone-to-zone combination.

The overall commercial exchange between two zones results from all the individual contributions of the different generation units located in different nodes of the two zones. The physical flow on a transmission line resulting from a zone-to-zone commercial exchange therefore depends on the locational distribution of generation (and demand) inside the two zones. In the computation of the zonal PTDFs, this dependency is taken into account through the GSK (see §2.3.7).

2.3.7. Generation Shift Keys (GSK)

GSKs are crucial in the current CWE FBMC implementation. GSKs are the building blocks for the computation of zone-to-zone Power Transfer Distribution Factors (PTDF, see §2.3.5 above). They are also used to define the reference flows in the base case (Fref', see §2.3.2 above).

GSKs are assumptions made on the participation of a power generation unit to a change in the Net Exchange Position of a bidding zone. As the effective participation of a generation unit depends on the results of the market coupling and the clearing price, this results in a circular problem: in order to compute transmission capacities, TSOs need the contribution of individual units, and the contribution

of a unit to the market is mainly driven by the result of the market coupling, i.e. the clearing price. This circularity does not exist in the case of a nodal approach where the bid price and the location provide enough information for an exact calculation and allocation.

The larger a price zone, the more important a good assessment of GSK by TSOs become. Given the circularity of this assessment, it is clear that a good assessment of GSK in large price zones becomes very difficult, if not totally impossible. This results in higher locational uncertainty (translated into higher FRM values) and lower capacity for cross- zonal exchange (lower RAM).

CWE TSOs adopt different methods to determine and calculate the GSKs. RTE defines the GSK of each generation unit as proportional to its contribution to the total expected generation. German TSOs do the same, but only for the flexible generation units such as gas-fired and hard-coal power plants. Renewable generation, lignite and nuclear power plants are considered as must-runs and are integrally included in the base case (see § 2.3.2 above). Elia and Tennet NL also solely define GSKs for the flexible ('market driven') power plants. The GSKs of these generation units are based on the plant capacity and proportional to the difference between maximum and minimum zonal net exchange position.

2.3.8. CBCO-selection

The inclusion of a CBCO in the FBMC is an individual TSO discretionary action, as well as the determination of most of the parameters characterizing that CBCO.

In the CWE FBMC, CWE TSOs now use the 5% PTDF-rule as selection criterion for the CBCOs. Following that rule, a transmission network element is considered as a CB or a CBCO if this network element is significantly impacted by CWE cross-border trade which means for CWE TSOs that its maximum zone-to-zone PTDF is larger than a threshold value of 5%. A zone-to-zone PTDF of 5% for an exchange between Belgium and the Netherlands on a given CBCO means that the physical flow on that CBCO is estimated at 50 MW for a 1000 MW commercial exchange between the two countries.

2.3.9. LTA-inclusion and LTA-violation

Given that Programming Authorisations for long-term allocated capacity (LTA) have already been sent out in D-2 Working Days (firmness requirement), the long-term allocated capacities of the yearly and monthly auctions have to be included in the initial Flow Based-domain. This will avoid that the flow based domain provided to the day-ahead allocation (after taking into account the cross-border nominations) would not include the 0 hub-position point. This can be checked after each Flow Based-parameter-calculation. The fundamental reasons for designing this "LTA coverage" is linked to congestion rents revenue adequacy concerns and the compensations to be paid to the holders of LT rights. If the remaining margin is smaller than zero, this means that the LTA is not fully covered by the Flow Based domain. In this case, a method is applied that 'virtually' enlarges the Flow Based-domain in a way that all LTAs are included. CBCOs which violate the LTA, are replaced by "virtual CBCOs", which are mathematically determined to guarantee the inclusion of all LTAs in the flow-based domain. The term 'LTA-violation' refers to the case where the market clears in a corner of the flow based domain which was virtually increased (see Figure 4).

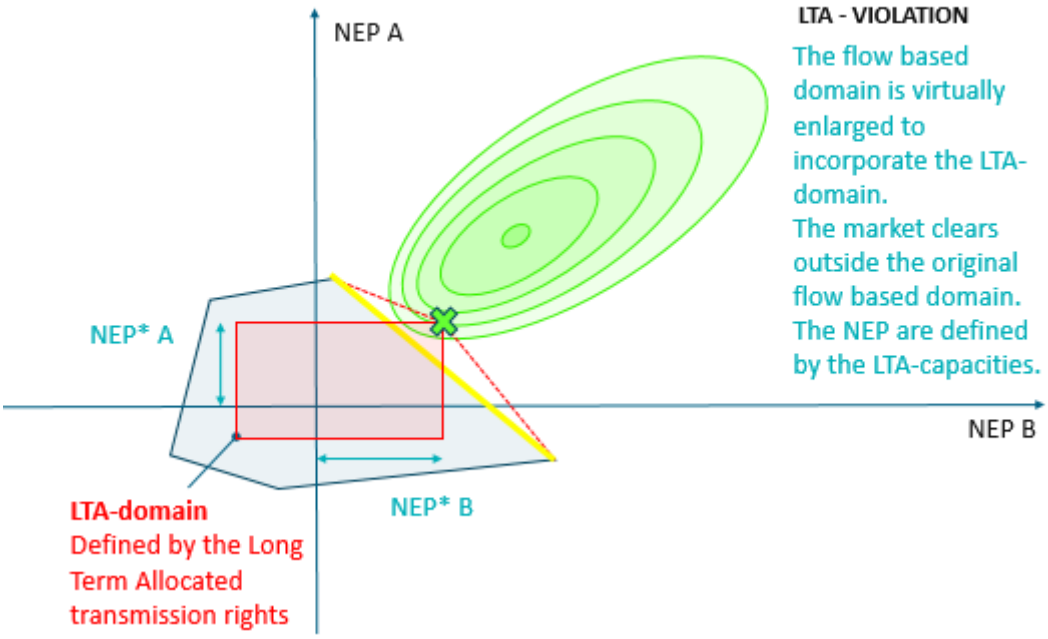


Figure 4 : LTA-inclusion assures TSOs financial adequacy for remunerating long-term capacity holders by increasing the flow based domain in the case the flow-based domain is not large enough to cover all allocated long-term capacities (LTA-domain). Source: CREG

2.4. CWE NRAS POSITION PAPER AND CREG DECISION ON THE CWE FLOW BASED MARKET COUPLING PROPOSAL

CWE NRAs have indicated their common understanding for the implementation of a FB MC in the CWE region in a "Position Paper of CWE NRAs on Flow-Based Market Coupling" (see annex [5]). This paper serves as basis for the elaboration of the individual decision of each NRA leading to the go-live of the CWE market coupling In May 2015. The CWE FBMC methodology, described by CWE TSOs in the Approval Package in 2015, was, as indicated in that Position paper, considered as compliant with most of the legal requirements of the European Regulatory framework.

Nevertheless, the Position paper identified, in Section 4 on the Consistency with the European legislation, several possible sources of non-compliance as indicated in the following paragraphs which literally cited from the Position paper.

"The definition of a base-case implicitly gives priority to internal trade on cross-border trade. Therefore, the CWE NRAs stress the importance of the base-case not to load the grid in a disproportionate way and of the GSK to be determined according to clear and transparent rules, defined ex-ante by TSOs and approved by NRAs. Otherwise the proposed methododology could be in breach with Article 16.1 of Regulation 714/2009, which provides that network congestion shall be addressed with non-discriminatory market-based solutions.

A more precise definition of flows allows another explanation of the base-case question. In this new definition, loop-flows are physical flows resulting from internal trades within one bidding zone through another bidding zone. As these internal trades are included mainly in the base-case and thus create a pre-market loading of the transmission grid which is used as the starting point of flow based, loop-flows cannot be better managed in FB than in ATC. The only way to have this model deal with loop-flows is by creating appropriate network areas between which congestion management is applied. It

is to be noticed that loop-flows are better manageable by TSOs in a FB environment as far as the base-case hypotheses are shared. Moreover, transit flows (physical flows induced in a given zone by a commercial flow between two other zones) are explicitly taken into account by the FB mechanism to reach a better use of the grid and an optimized set of exchanges.

A CB located inside a bidding zone, if corresponding to a structural congestion, may, if bidding zones are not optimised, constitute a source of non-compliance with article 1.7 of Annex 1 of Regulation 714/2009 dealing with congestions observed on internal network elements systematically pushed to the borders and not solved by other methods (re-dispatching). Transmission grid reinforcements can also address the above issue. The monitoring of the most frequently active CB is thus a key element of the monitoring tool required by CWE NRAs.

Nonetheless, it has to be highlighted that the above-mentioned sources of possible non-compliance do not intrinsically derive from the use of FB. Such risks are inherent to a zonal approach where either bidding zones have not been optimised yet, as precisely requested by the bidding zone review prescribed by the CACM Regulation, or necessary grid developments are not in place yet.

The use of external constraints (and the dimensioning of the Flow Reliability Margins "FRM" hereafter) shall be fully justified. Falling that, it may raise a risk of non-compliance in light of article 16.3 of Regulation 714/2009, which calls for the maximum capacity of the transmission system affected by cross-border flows to be offered to the market complying with safety standards of secure network operation. The studies listed in section 9.7 are to mitigate this risk. The studies should justify the external constraints currently foreseen in the Approval Package. If they cannot be justified, these external constraints will have to be either removed or adapted to ensure the compliance of the methodology with the legislation."

To address the possible sources of non-compliance, CWEs NRAs required several improvements to be made by the TSOs to the CWE FB methodology. Requirements linked to this study are recalled below:

- A monitoring of the Flow Factor Competition issue which was also the object of a specific Memorandum of Understanding of CWE NRAs
- The completion of agreed transparency requirements
- A justification (9 months after go-live) and, if appropriate, a revision of proposed external constraints
- An investigation of measures which may lead to a reduction of the FRMs while respecting security criteria and a proposal of modifications if appropriate (12 months after go-live)
- The justification of the "5 % rule" applied for the selection of the CBCOs and the proposal of a better rule if appropriate (for the submission of TSOs proposal for capacity calculation as foreseen in the CACM Guideline - this corresponds to the 17 of September 2017 when CORE TSOs have made their proposal)
- Harmonization of the rules for the determination of GSKs to increase transparency, reduce uncertainty and avoid discrimination. These GSKs should be adapted for each hour of the D day. This improvement has to be implemented at the latest when applying for a capacity calculation methodology in the frame of the CACM Guideline (same date as above).
- In relation to Article 17 of CACM Regulation on the Common Grid model (at the time of CWE position paper, it was Article 16), a contribution to the development of the common grid model and harmonization of the base case. Again, this contribution should have been delivered for the 17 th of September 2017.

It was agreed that the bidding zone question has to be solved in the frame of CACM Regulation.

Given the non-compliances of the CWE FBMC proposed methodology related to discrimination (prioritization of exchanges in the base case), to the fact that congestions are pushed to the border (critical branches located inside a bidding zone), to the absence of a maximisation of commercial

exchanges (external constraints), to a non-market based allocation (determination of GSK) and a non-adequate definition of bidding zones, CREG only conditionally approved, in its decision # 1410 [5], the go-live of CWE FBMC on the grounds of the expected improvements compared to the former ATC-method as assessed through two years of FBMC parallel runs (showing an increased welfare and price convergence) and under a series of conditions for further improvements of the methodology. Improvements required by CREG were in line with the CWE NRAs position paper and CACM Guideline content and timing.

Up to today, a significant number of the suggested improvements and indicated non-conformities have not been fully addressed or implemented yet.

3. MARKET IMPACT OF TSO DISCRETIONARY ACTIONS

Along the years, collective and individual TSO decisions have shaped the overall design of FBMC and its implementation. Within the current legal framework, there is a large degree of freedom for TSO to take individual/collective decisions in the day-to-day operation. This chapter analyses the impact of TSOs collective and individual discretionary actions on FBMC. The overall design and implementation of the FBMC, which is a collective TSO responsibility, is examined first. Next, discretionary actions of individual TSOs are examined.

3.1. DESIGN OF THE ZONAL FLOW BASED MARKET COUPLING

3.1.1. Discretionary action

Around 2002-2004, when the idea of a market coupling was launched, there was a common and shared awareness on the need to base the global design of a market coupling on adequate bidding zones. In 2006, the Annex 1 of Regulation 714 was modified and since that time the TSOs have the responsibility to define *"appropriate network areas in and between which congestion management is to apply"* which corresponds to the adequate definition of bidding zones in today's parlance. In 2007, CWE NRAs Action plan [1] requested the realisation of an Orientation study, containing the examination of two different options for the foreseen market coupling based on one or on several "node(s)" per country, which corresponds to what is called a "bidding zone" today. This request was fully endorsed by the CWE Pentalateral Energy Forum Memorandum of Understanding (CWE PLEF MoU) signed a few months later, where an explicit reference to this Orientation study was made.

Since the launch of the FB project, CWE NRAs have clearly indicated their concern with the risk of discrimination linked of the prioritization of internal trade and to the impact of the bidding zone configuration. The examination of different bidding zones configuration required in the Orientation study has never been performed, given a lack of support of German counterparts.

Large bidding zones cause pre-congested cases, meaning that the zero cross-zonal exchange reference situation Fref is not feasible without overloading network elements in N or N-1 situation. The problems linked to pre-congested cases have delayed the development of the FB method for nearly two years. However, even then, the option to adopt smaller bidding zones (leading to a drastic reduction of Fref) has never been seriously considered: A study on the impact of different bidding zone configurations was started in 2011, with some results showing the impact of the bidding zone delimitation on the loop-flows but no alternative, better configuration of bidding zones of the CWE region was produced.

Later, this question was *de facto* transferred to the CACM Guideline bidding zone review process. This Guideline stipulates that ACER shall assess the efficiency of the bidding zone configuration every three years and that a review of the bidding zone configuration can be triggered on this basis. This review, started a few years ago on a voluntary basis, should deliver in principle proposals for a better bidding zone configuration for (most of) the continental part of Europe in March 2018, as planned today.

The status quo on the bidding zones question has resulted in

- uncontrolled loop-flows;
- the need for critical branches located inside bidding zones;
- uncertainty, translated in important security margins (FRMs);
- distributive effects due to flow factor competition.

leading to inefficiency, discrimination and reduced and unfair competition.

3.1.1.1. *Loop-flows*

Loop-flows correspond to physical flows observed on a network element resulting from domestic exchanges inside another bidding zone. They correspond to externalities for economists.

In a zonal design, it is assumed that there is no or only residual congestions inside the zone (which can be considered as a copper plate) and that a zone generates only a limited amount of loop flows (has nearly no impact on its neighbours).

Loop flows scale with the power and with the distance of the commercial exchange. Large bidding zones create important loop flows. The ratio of loop-flows generated by Belgium compared to those generated by Germany is in the ratio of 1 to 100 – 10 times relative more power in Germany on a distance 10 times longer.

Loop-flows are a direct consequence of the laws of physics (Kirchhoff laws) and any commercial exchange impacts the entire network - including lines in other bidding zones. Loop-flows are not a fatality, and the resulting automatic and instantaneous netting of flows in the opposite direction constitute a valuable property. Loop-flows can be tackled properly through an adequate design (small bidding zones and a flow-based implementation) or via a nodal approach where all the benefits linked to this electrical property are valuated.

Loop flows can only be reduced structurally through a reduction of the size of bidding zones.

The current implementation of a flow-based mechanism in the CWE region is based on a two steps approach, starting with the definition of a base case, corresponding to the juxtaposition (the sum) of flows resulting from domestic trades inside the 4 bidding zones (the loop-flows and internal flows), followed by the allocation of the remaining transmission capacities for cross-zonal trade. With other words, capacities are reserved for allowing domestic trades and remaining margins, what is left, is offered to the flow-based cross zonal optimisation. The FB MC optimises the use of the remaining transmission capacities made by the flows resulting from cross-zonal exchanges. These flows are called transit flows. No measure is taken in the current FB implementation to mitigate the “de facto” priority given to domestic trades inside a bidding zone on cross-zonal exchanges.

Because they are determined by the market – and their impact on the grid reflected in the market clearing prices – transit flows are also called ‘competitive flows’. Transit flows are arbitraged, optimized and managed by the FBMC. This is not the case for loop flows. These physical flows, associated with domestic trade, get priority access to the grid. Because they do not compete with other commercial exchanges to access the grid, those flows are also called ‘non-competitive flows’. The smaller the magnitude of the loop flows, the more effective and competitive the use of the grid network infrastructure.

In the case of a German North – South exchange, only half of the power is going through the German transmission system and the rest is loading other systems. No serious compensation is given to the other countries for this: the Inter TSO Compensation (ITC) mechanism seems to remunerate large countries for the generated loop-flows as they are considered as “transit” flows.

These loop-flows are so important in the EU bidding zone configuration that sometimes nothing is left for cross-border trade. These situations are called pre-congested cases. The impact of loop-flows on cross-border trade will be demonstrated in §3.1.2 below.

3.1.1.2. *Internal Critical Branches*

Large bidding zones are more prone to congestions located deeply inside the bidding zone. This is because domestic commercial exchanges do not consider the physical limitations of the domestic grid.

The grid inside a zone is assumed to be a copper plate with an infinite capacity. The selection of generation units in the market clearing step depends solely on the supply bid price, and not of its location.

In order to facilitate the management of congestions on these network elements, TSOs have proposed to use the FB MC to manage the congestions on these internal network elements, in contradiction with Article 1.7 of Annex 1 of Regulation 714/2009.

The contradiction arises from the fact that internal network elements are considered to have infinite transmission capacity for hosting physical flows arising from domestic trade, while having finite capacity for hosting physical flows arising from cross-zonal trade.

The analysis of discretionary actions related to the definition of critical branches located inside bidding zones and its impact are analysed in Section 3.2 and Section 3.3 devoted to the examination of discretionary actions of individual TSOs.

3.1.1.3. *Uncertainty*

When recommending the implementation of FBMC in 2006, it was assumed that the impact of cross-zonal commercial trade on transmission network elements can be computed with an adequate level of accuracy. This can only be done if a sufficient locational information on the origin and the destination of the commercial trade is available. In a zonal design, this information has a zonal resolution.

Smaller bidding zones provide a higher spatial resolution on the origin and destination of commercial flows, enabling TSOs to forecast the volume and direction of physical flows more accurately. The presence of large bidding zones is therefore not compatible with the implementation of an efficient FBMC, given the high uncertainty of the assessment of the impact of a given trade on transmission network elements.

To cope with this locational uncertainty, TSOs take specific security margins (in addition to the N-1 rule), the FRM, which reduce the volume of cross-zonal trade and competition, the efficiency of the FB implementation and which today lead very often to zero commercial capacities, making the recourse to the LTA inclusion patch structural.

In a paper published in 2013 [3], CREG has highlighted the link between the uncertainty, the FRM, the size of the bidding zone and the location of critical branches.

3.1.1.4. *Flow Factor Competition*

Finally, a mix of small and large bidding zones gives rise to flow factor competition, granting a structural competitive advantage to large bidding zones over smaller ones in a (pure) FB model:

- When a small and a large zone both want to import and compete for transmission capacity on the same CBCO, the larger zone will typically be able to import relatively more and at a lower price than the smaller zone, through the lower PTDF associated to an exchange with the larger zone.
- When a small and a large zone both want to export and compete for transmission capacity on the same CBCO, the larger zone will typically be able to export relatively more and at a higher price than the smaller zone, through the lower PTDF associated to an exchange with the larger zone.

The origin of this issue is not physical but is related to the specific implementation (the current zonal approximation of a transmission system translated in the calculation of PTDFs) of FBMC in CWE. The problem is duly elaborated in the paper cited above [3].

For small zones, flow factor competition gave rise to concerns on system security. With the original FB proposal, it was perfectly possible that the market price in a small zone as Belgium hits the cap of 3000€/MWh without being able to import while at the same time a larger zone can import at a lower market price.

To guarantee system security, the FBMC design has been complemented with an adequacy patch which is triggered when the price cap of 3000€/MWh is hit. The threat for a structural competitive disadvantage for smaller zones still exists, however. With the current problems encountered with the FBMC, with the too many LTA inclusions, the impact of this phenomenon should not be important in the current circumstances. More on this is expected with the publication of the results of the study made on the Flow Factor Competition, realised on the basis of the MOU made in April 2015 by CWE NRAs on this issue.

3.1.2. **Impact**

The impact of loop flows can be reflected in global figures such as the social welfare losses due to the reduction of the possibilities for trading. This impact can also be measured on the prices of the affected bidding zones.

3.1.2.1. *Loop flow impact on welfare for Europe*

In the 2015 Market Monitoring report, Key Insights and Recommendations, ACER presented an estimation of the welfare losses linked to the unscheduled flows (UF), which are equal to the sum of loop-flows (LFs) and the unscheduled allocated flows (UAFs). The volume of UF in 2015 is estimated to 160 TWh and the associated social welfare loss in the different European regions close to 1150 million euro. It is estimated that 40% of this loss is due to loop-flows.

ACER also calculated the welfare losses due to Unplanned Flows (UFs) per border and per region. In the Annual report on the Results of Monitoring the Internal Electricity Markets in 2015 [9], the welfare loss on Belgian borders in 2015 due to loop flows is estimated at **60 M€,** and the welfare loss due to the unscheduled allocated flows (UAF) at 64 M€. The total welfare loss caused by UFs for the CWE region for the year 2015 is estimated at 276,5 M€.

3.1.2.2. *Loop flow impact on price spikes on the wholesale electricity market for Belgium*

In March 2016, CREG delivered the Study CDC-1520 on “the price spikes observed on the Belgian day-ahead spot exchange Belpex on 22 September and 16 October 2015” [7], published in English. The main conclusion of this study is that the origin of these prices spikes lies in the loop-flow which have priority access on the interconnection (due to the capacity calculation method and the presence of large bidding zones). This result was confirmed by Elia, the Belgian TSO. Even if for these hours, Belgian physical imports were coming from France, it was the North border of Belgium which was overloaded in the North-South direction due to loop flows in the same direction. For example, if France exports 2500 MW to Belgium, as it was the case on 22nd September, about 75% of 2500 MW (1875 MW) will be a direct flow going through the transmission lines between France and Belgium. The remaining 25% will follow an indirect path via Germany and the Netherlands (and via Switzerland, Italy…) to Belgium. This is called a transit flow: a power transfer between two bidding zone that physically passes through other bidding zones (and which – in contrast to loop flows – are competitive flows and properly

managed by the FBMC). To summarize, a power shift of 2500 MW from France to Belgium will result in 1875 MW physical flows on the French-Belgian border (direct flow) and 625 MW physical flows on the Dutch-Belgian border (transit flow). So, if 1800 MW of physical flows are measured on the Dutch-Belgian border (as it was the case for example during hour 15 on 22 September) whereas only 625 MW were expected due to the French origin of the imports from France, 1175 MW out of the 1800 MW on the Dutch-Belgian border are (mostly) loop flows (1800 MW – 625 MW = 1175 MW).

Prices spikes above 400€/MWh have been observed the 22nd September. According to an analysis performed by CREG based on supply and demand curves in the Belpex orderbook, an increase of 1000 MW of the import capacity would have led to market clearing prices in the range of €45/MWh to €55/MWh during hours 8-21. So approximately an impact of 350€/MWh for the non-competitive flows on the hourly day-ahead price.

Data provided by Elia on the hourly values of loop flows through the Belgian network in the base case (D-2), show that actually all Belgian price spikes recorded in the period June 2015 to December 2016 occurred when the loop flows exceeded the value of 1000 MW (see Figure 5). Loop flows through Belgium were equal to +873 MW on average of positive North South and negative South North flows.

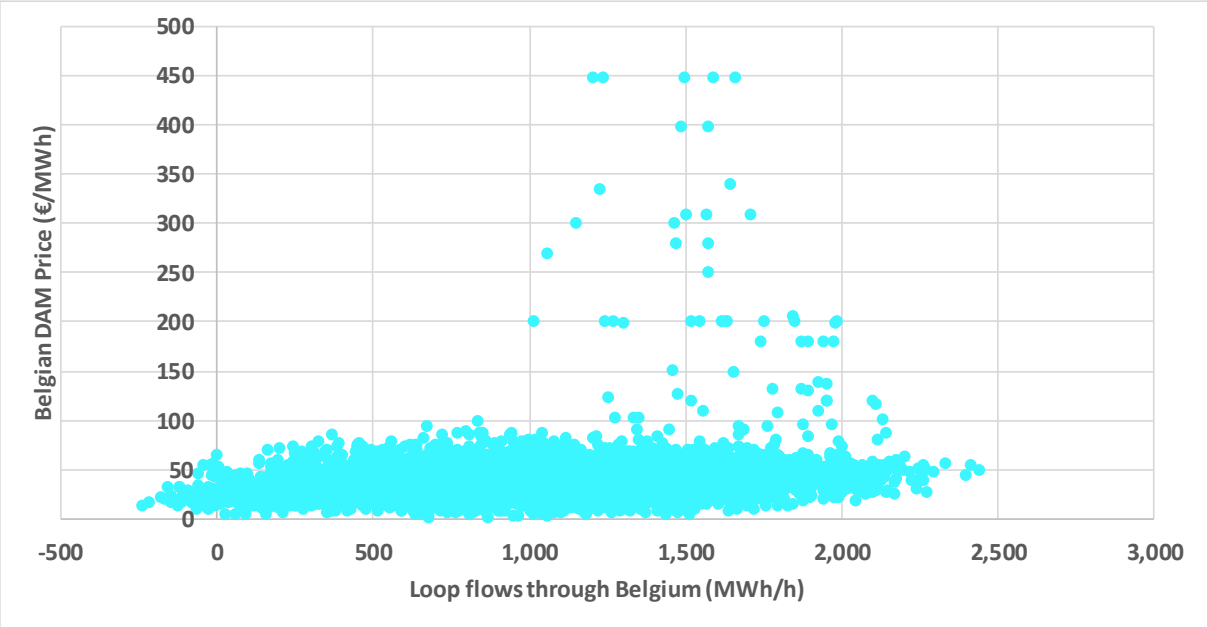


Figure 5 : Belgian day-ahead prices versus D-2 loop flows for all hours in the monitoring period July 2015 to December 2016. Positive loop flows indicate physical flows crossing the Belgian network from North to South. Source: Data from Elia and post-processing by CREG

In its study [7], CREG indicated in his conclusions that "*the analysis of both days makes it very clear that non-competitive flows, for the largest part loop flows, have priority access to the cross-border capacity, regardless of the scarcity of this capacity or the willingness to pay for it. Sometimes much more than half of the observed physical flow are non-competitive flows. This is even true if market participants are willing to pay the maximal price of 3000 €/MWh, which increases the risk for security of supply. This is clearly not compliant with Regulation 714/2009 and its Annex 1.*"

3.1.2.3. <u>*Loop flow impact on congestion on the Belgian network*</u>

For smaller bidding zones such as the Belgian one, loop flows also contribute to creating internal congestion. Loop flows not only reduce the RAM on interconnectors, but also the RAM on internal critical lines, triggering internal congestion faster than in the cases without loop flows. The

contribution of loop flows to internal congestion is almost negligible for the larger bidding zones since those have less loop flows. This issue is further discussed in Section 3.2, where the occurrence and characteristics of active constraints on internal critical branches in the FBMC are analysed.

3.1.2.4. *Loop flow impact on system operation and reserve capacity needs*

Loop flows also cause indirect economic costs related to increased uncertainty on system operation ([3]) and the need for more reserve capacity ([4],[5]). In its Adequacy Study for 2017 - 2018, Elia identified the scenario with high wind infeed in Germany as the worst-case situation in terms of Belgian import capacity. The level of wind infeed in Germany is found to be the key parameter defining the size of the flow-based domain and thus on the Belgian import capacity. Especially when both France and Belgium are importing, the impact of the wind infeed in Germany on the Belgian (and French) import capacity is detrimental. This can be observed from the small size of the flow based domain in this market corner, see figure below, left.

In its Adequacy Study for 2018-2019, Elia calculated that the planned Belgian grid reinforcements will – alone - not improve this situation. As shown in the figure below, right, the size of the flow based domain – and corresponding combined French and Belgian import capacity, remains unaltered: Jointly, France and Belgium cannot import more than 2000 MW. This is only half the 4000 MW value with NTC.

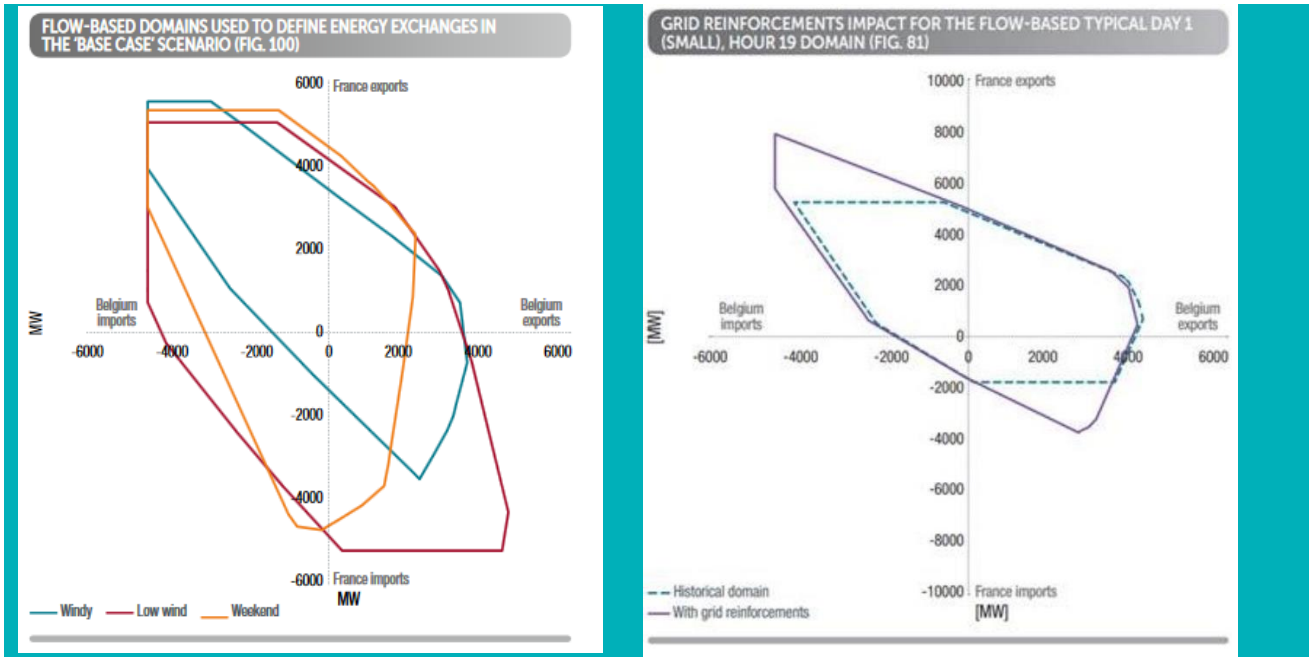


Figure 5 bis : Flow Based domain used by Elia in the scenarios for calculating the need for Strategic Reserves for 2017-2018 (left) and 2018-2019 (right).The fact that France and Belgium see their import capacity reduced when there is a high wind infeed in Germany (see also next paragraph §3.1.2.5) may

[3] Elia website, accessed on 24/08/2017: http://www.elia.be/en/products-and-services/cross-border-mechanisms/transmission-capacity-at-borders,

[4] Elia website, accessed on 24/08/2017: http://www.elia.be/~/media/files/Elia/Products-and-services/Strategic-Reserve/20161201_Adequacy-Study_EN_2017-2018.pdf

[5] Elia website, accessed on 13/12/2017 : http://www.elia.be/~/media/files/Elia/Products-and-services/Strategic-Reserve/171129_ELIA%20AR-Winter_UK.pdf

seem surprising from a purely market-based perspective. This apparent contradiction is explained by the reduction of commercially available capacity by to the loop flows generated by the internal commercial exchange of the wind infeed in the north of Germany to the consumption sites in the south and which currently have priority access to the network.

Based on an analysis asked by the CREG, Elia calculated that no strategic reserves would be necessary for the winter 2018-2019 if Belgium could rely on 3.000 MW of imports (or more). This clearly shows that an inefficient flow-based market coupling significantly increases the capacity needed for security of supply.

3.1.2.5. *Loop flow impact on the integration of renewables*

Loop flows also strongly restrict the export capacity of the German bidding zone. The CWE market coupling results of 1st May 2017, studied by CREG [13], show that despite the surplus of renewable energy in Germany and the large price spread with Belgium, France and the Netherlands, Germany was not able to export much more than 2000 MW. Prices in Germany were below -60€/MWh during those hours (Figure 6). Export of wind is hampered by loop flows, which in turn hampers the market integration of renewables.

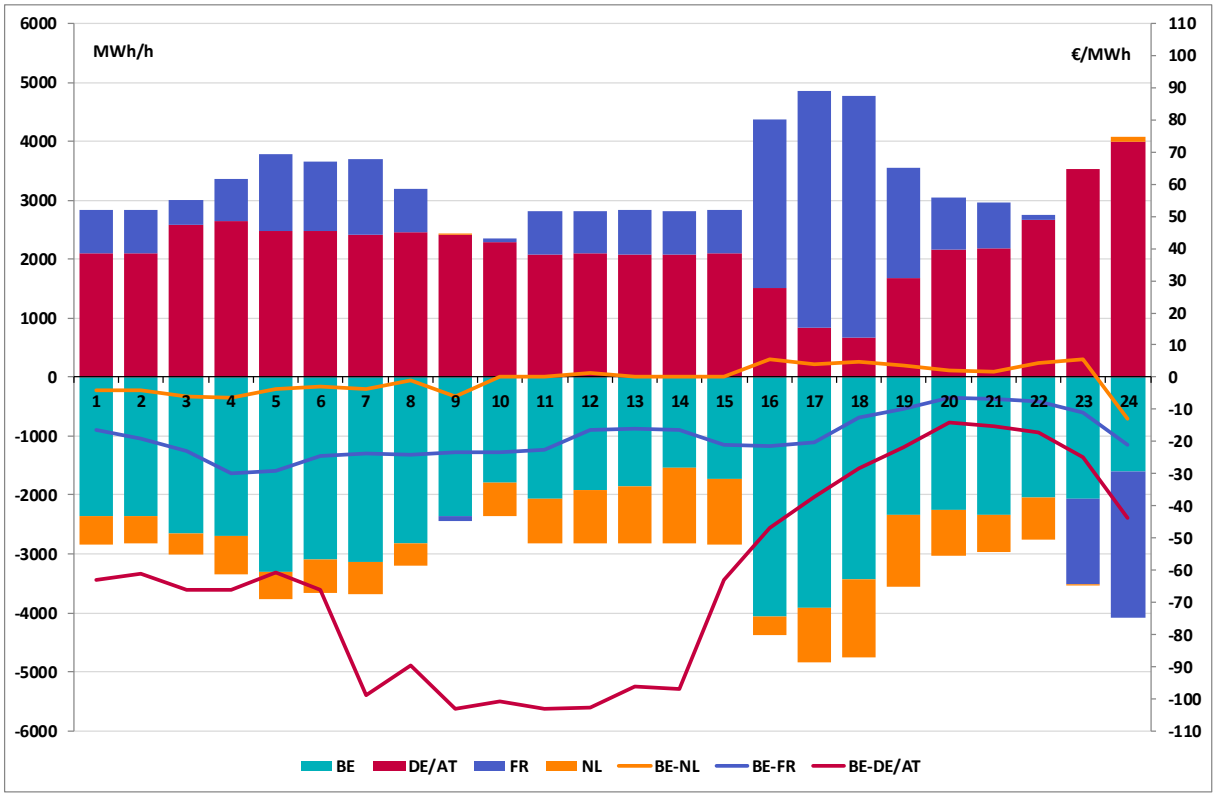


Figure 6: Day-ahead wholesale electricity net import and export positions per bidding zone and price spread between the Belgian bidding zone and the other 3 bidding zones in the CWE-region for the 1st of May 2017.
Source: CREG, Joint Allocation Office (JAO)

3.2. HIGHLY PRELOADED INTERNAL CBCOS MANAGED BY FBMC

3.2.1. Discretionary actions

The inclusion of CBCOs in the FBMC is an individual TSO discretionary action. For the sake of objectivity, measurability and security of supply, TSOs agreed on a common CBCO selection method, which is now known as the 5% PTDF threshold criterion. This method makes no distinction between internal or cross-border lines. This way, TSOs can use FBMC instead of local re-dispatching (or adequately defined bidding zones) to solve internal congestions - at the expense of cross-border trade.

3.2.2. Impact

Since the start of CWE FBMC, internal CBCOs have limited cross-zonal commercial capacity more often and more severely than cross-border CBCOs (see Table 1). These internal CBCOs are characterized by lower PTDF-values, lower RAM-values and higher shadow costs. Internal CBCOs are so often active because of their very small RAM. Even after LTA-inclusion, needed in 71% of the cases for internal CBCOs, the average RAM on active internal CBCOs was only 16%.

Table 1 : Average characteristics of active critical branches grouped by type for the period (01/06/2015 – 31/12/2016: 14185 hours). Note that in 30% of the congested hours, there was more than one active constraint. Source: Data from CWE TSOs, post-processing by CREG

Location of active constraint	Active hours (h)	LTA (% of Active hours)	PTDF (%)	RAM (MW)	RAM (%Fmax)	Shadow price (€/MW)	CWE Price spread (€/MWh)	CWE cross-zonal-vol (MW)
Cross-border CBCO	5005	39%	24%	603	44%	61	17	4093
Internal CBCO	5793	71%	13%	255	**16%**	**152**	20	2629
External Constraint	923	0%	100%	4931	92%	7	11	5834
All constraints	**11721**	**52%**	**24%**	**773**	**34%**	**96**	**18**	**3507**

High shadow cost for an active critical branch indicates that an increase of one MW of the capacity of that critical branch would have resulted in a high increase of the welfare of the FBMC. With other words, these lines provoke important reduction of highly valuated trade. Despite significant average price spreads (20 €/MWh), the average volume of cross-border trade for the whole CWE region during the hours when internal CBCO were the active constraints was only 2629 MW - far less than the average 4093 MW reached when the congestion appeared on a cross-border line. The opportunity cost of introducing these internal CBCOs in the FBMC is thus very high (average shadow cost of 152€/MW), suggesting that local re-dispatching would have been less costly and more efficient. High shadow costs typically result from internal CBCOs with very low RAM (Figure 7).

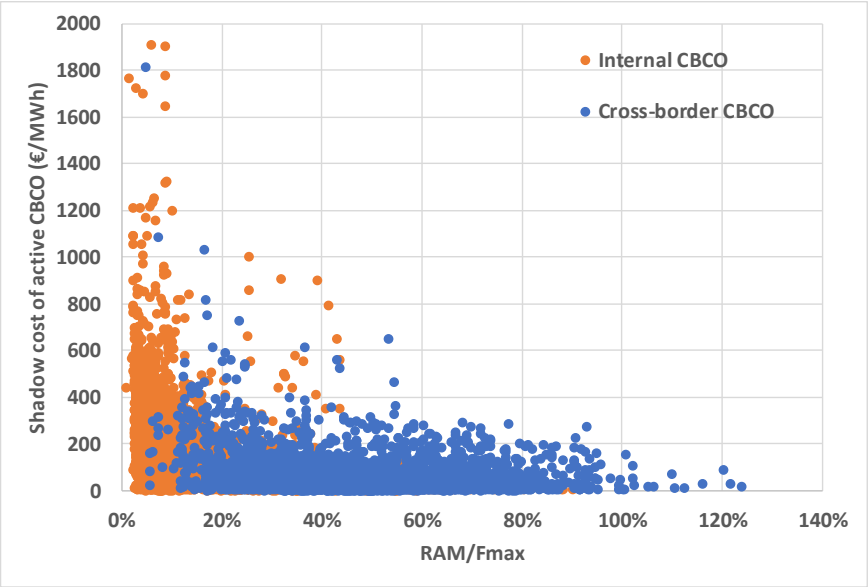


Figure 7: Each dot represents an occurrence of an active CBCOs in the period June 2015 – December 2016. High shadow costs typically result from internal CBCOs with very low RAM values. Source: Data from CWE TSOs, post-processing by CREG

The average characteristics of the Top 20 active internal CBCOs are presented in Figure 8 below. The height of the bar corresponds to the average line capacity (Fmax). The margin available for day-ahead cross-zonal trade (RAM), the flow reliability margin (FRM) and the reference flows prim are indicated for each critical branch. The "count" figure indicates the numbers of hours when a critical branch was active. Critical branches are ranked from the most active to the less active.

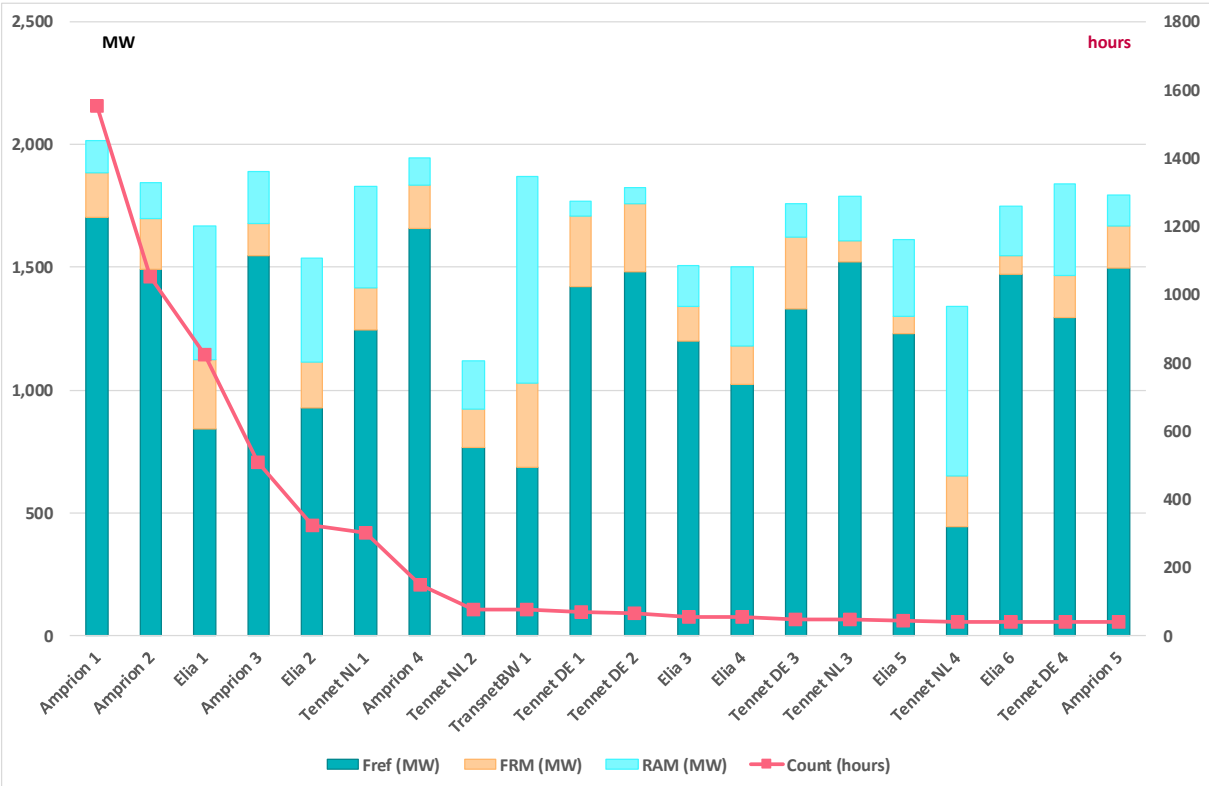


Figure 8: Average characteristics of the Top 20 internal critical branches when the CBCO was active (period 05/2015 – 12/2016), sorted by the number of active hours ('Count'). Source: Data from CWE TSOs, post-processing by CREG

This Figure illustrates one of the main problem of the implementation of the CWE FB MC where internal CBCOs in the German bidding zone were close to pre-congestion when active, with little capacity left for commercial exchanges (low RAM). The average RAM (%Fmax) was especially low on Amprion lines:

- Amprion 1 (Knapsack-Sechtem): Average RAM of 6.8%, evaluated over 1552 active hours
- Amprion 2 (Rommerskirchen-Knapsack): Average RAM of 8% evaluated over 1053 active hours
- Amprion 3 (Hanekenfaehr – Gronau): Average RAM of 12%, evaluated over 507 active hours
- Amprion 4 (Rommerskirchen-Sechtem): Average RAM of 6%, evaluated over 147 active hours

As a comparison, the average RAM (%Fmax) on lines from Elia and Tennet NL were typically higher:

- Elia 1 (Doel-Zandvliet): Average RAM of 38% evaluated over the 825 active hours
- Elia 2 (Mercator-Rodenhuize): Average RAM of 28% evaluated over the 324 active hours
- TennetNL 1 (Ens – Lelystad): Average RAM of 24% evaluated over the 299 active hours

In total, Amprion internal lines accounted for 29% of all congestions in the period July 2015 – December 2016; with an average shadow cost of 180 €/MWh compared to the total average of 96 €/MW. During the 4 winter months November-December 2015 and November – December 2016, the average shadow cost was even higher: 237 €/MW compared to the total average of 144 €/MW.

Elia internal lines accounted for 12% of all congestions with an associated shadow cost of 59 €/MW on average. On average, the highest shadow costs were linked to internal lines in the Tennet DE region, namely 298 €/MW, active in 3% of hours. Internal lines of Tennet NL, TransnetBW and RTE have been active in 4%, 1% and 1% of hours respectively, with respective average shadow costs of 111 €/MW, 240€/MW and 73 €/MW.

When comparing the occurrence and characteristics of internal CBCOs of Amprion with the ones of Elia and Tennet NL, it is important to keep the following two elements in mind:

- Firstly, the origin of the preloading (Fref') is not the same. In the Amprion area, Fref' almost exclusively originates from domestic trade inside the German bidding zone. In the Elia and Tennet NL area, by contrast, Fref' includes relatively high volumes of loop flows. The latter is illustrated by the results of the scenario 3 of the simulations made by the TSOs for November 2016, as discussed in §3.3.2. In this scenario, the phase shift transformers (PST) on the Belgian-Dutch border were used in the base case to limit the loop flows through Belgium to 500 MW. By this measure, the number of congestions inside the Elia and Tennet NL area would have fallen by respectively 80% (from 61 to 12 hours) and 56% (from 80 to 35 hours), while the congestions inside the Amprion area would have raised by +165% (from 135 to 356 hours) compared to the historical data of November 2016. With other words, limitation of the loop flows at the Belgian border "pushed back" the physical flows back to Germany, relieving the network of Elia and Tennet NL (lower Fref').

- Secondly, the magnitude of the zone-to-zone PTDF of the internal CBCOs differs. For the CBCOs inside the Elia and Tennet NL area shown above, the PTDF- values range from 14% to 35%, while for the ones in the Amprion area the PTDF-values are 8% or lower. It can thus be argued that the internal lines of Elia and Tennet NL considered here are a part of the backbone for cross-zonal exchange – and thus need to be managed within FBMC. It is questionable that this argument holds for the internal lines inside the Amprion area.

A last element in the discussion of discretionary TSO actions concerning the introduction of internal CBCOs in the FBMC, is the use of the exception to the 5% PTDF threshold rule, In the CWE FBMC Approval package, CWE TSOs propose that - in exceptional conditions – a TSO may add a CBCO for which the PTDF is below the 5% threshold. Those events must be justified to the NRAs. Analysis of the

use of these exceptions reveals that these CBCOs – when active – have been severely constraining the flow based domain, with high associated shadow costs. The monitoring data show that 90% of the total impact in terms of welfare loss, was caused by exceptional CBCOs introduced by Amprion and Tennet DE.

3.3. ADDITION OF INTERNAL CBCOS AFTER THE GO-LIVE OF FBMC

3.3.1. Discretionary actions

During the summer of 2015, Amprion added at least 4 new critical branches located inside their system, namely:

- Knapsack-Sechtem: appeared for the first time in the CBCO-set on 23/07/2015
- Rommerskirchen-Knapsack: appeared for the first time in the CBCO-set on 25/07/2015
- Rommerskirchen-Sechtem: appeared for the first time in the CBCO-set on 23/07/2015
- Opladen - Rommerskirchen: appeared for the first time in the CBCO-set on 18/08/2015

Note that the first three are the ones identified as having been amid the most constraining CBCOs (see respectively Amprion 1, Amprion 2 and Amprion 4 in Figure 8).

The addition by Amprion of new critical branches just after the launch of the flow-based market coupling is surprising. Parallel runs (simulations) of the functioning of the FB market coupling lasted more than 2 years. Their objective was the demonstration of the reliability of the proposed method, the evaluation of the benefits of flow-based compared to ATC and to allow market players to better grasp the functioning of flow-based. In addition, it should be noted that these additions appear at a time when no approved CBCO selection rule exist and when the TSOs have not fulfilled NRAs requests as indicated in their position paper.

Due to the initial lack of transparency related to the critical branches, CREG (and the other CWE NRAs) has not been immediately informed of these additions and of the importance of their impact.

3.3.2. Impact

The four CBCOs introduced after go-live of FBMC have been amongst the most constraining of all CWE CBCOs (2790 hours active – or 24% of all active CBCOs).

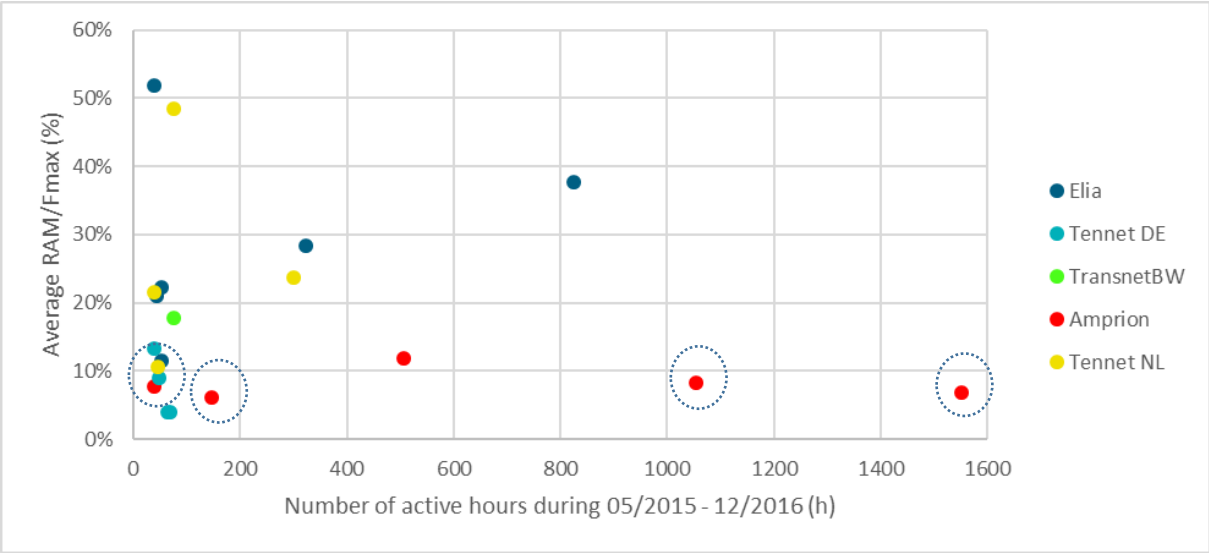


Figure 9: Occurrence and average RAM (%Fmax) of the Top 20 active internal CBCOs, grouped by TSO. The ones encircled have been added after the go-live of FBMC. Source: Data from CWE TSOs, post-processing by CREG

The characteristics of the congestions provoked by the 4 internal CBCOs of Amprion, compared with all the other congestions caused by other CBCOs, are indicated in red in Figure 10 below. Each dot represents a congestion occurrence. On the left, the congestions occurrences are plotted in function of the RAM (in % of Fmax) (horizontal axis) and in function of their PTDF (vertical axis). On the right, the vertical axis represents the shadow cost of a congestion occurrence.

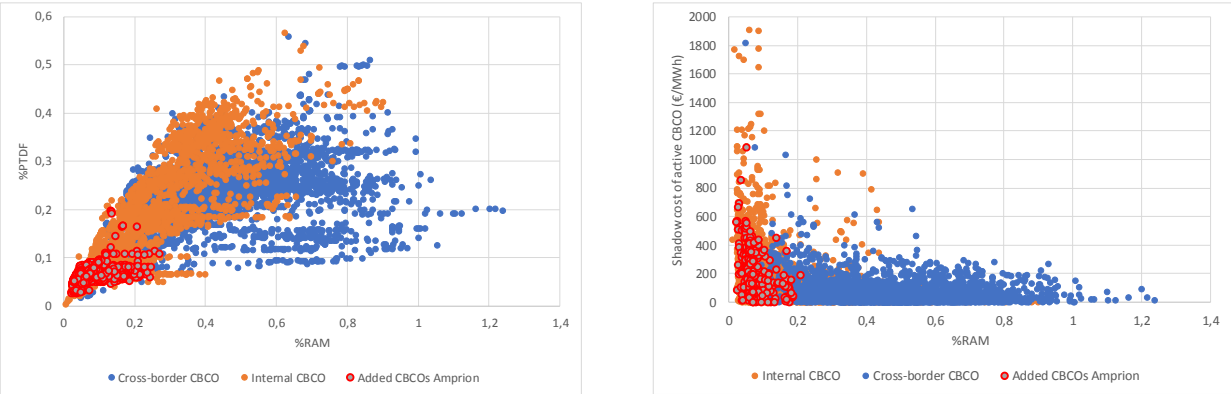


Figure 10: The characteristics of CBCOs (when active constraint) in the period May 2015 – December 2016, show different properties of %PTDF and %RAM (top-left) and shadow cost (top-right) depending on the type (internal/cross-border). Amprion congestion occurrences are indicated in red. Source: Data from CWE TSOs, post-processing by CREG

The low PTDF-values and low RAM values, indicate that these CBCOs are only marginally affected by cross-zonal trade and highly preloaded by internal exchanges present in the base case (Fref'). The high shadow costs associated with these active CBCOs, indicate a high impact on the socio-economic welfare related to cross-zonal trade.

The impact of these additions has been duly studied by CWE TSOs and NRAs. The impact has been quantified on the basis of the following 2 elements:

- A study requested by CREG on November 2016 events
- CWE TSOs presentation at the CWE Consultative Group meeting, 28th of February, Brussels

November 2016 events

In November 2016, due to the lack of available nuclear capacity in France and Belgium, both countries where at the same time in an import situation. Total imports for both countries were limited to 3400 MW on average (plus approx. 400 MW of LT rights) which constituted very often a very low market outcome (the year before, Belgium alone was able to import as much as 4300 MW). Situations where Belgium was only able to import 2000 MW, even at a very high price, were encountered frequently.

The monitoring of data revealed that these import limitations were linked to the few critical branches added by Amprion after go-live, having an average RAM of merely 10% when active. It is important to understand that the internal lines responsible for these congestions in Amprion area were loaded around 86% by exchanges present in the reference case in the absence of cross-zonal exchanges (Fref'), which clearly indicates that the problem found on these lines have a domestic origin.

Triggered by these events, CREG requested Elia to perform simulations for the month of November 2016 for three scenarios amongst:

- Scenario 1: Application of winter limits (Fmax increase of 20%) on Amprion CBCOs,
- Scenario 2: Neutralization of the CBCOs added after go-live and removal of positive FAV values on the three interconnection lines between Amprion and Tennet NL area,
- Scenario 3: Use of PSTs on Belgian-Dutch border to keep the D-2 loop flows expectations through Belgium below 500 MW, if possible.

The first scenario was justified by the fact that Amprion still used in November 2016 thermal line limits (FMAX) defined in summer conditions.

Elia performed the simulations in coordination with the other CWE TSOs. The results are summarized in Table 2.

Table 2 : Average net positions, day-ahead prices, CWE exchanged volume and price spread for November 2016 for the 3 simulated CBCOs-scenarios

		CWE Day Ahead Net Position [MW]				CWE Day Ahead Prices [€/MWh]				CWE vol	Price Spread
		BE	DE	FR	NL	BE	DE	FR	NL	MW	€/MWh
Reference	**mean**	**-1231**	**3192**	**-2077**	**115**	**62,4**	**38,2**	**65,2**	**42,9**	**3694**	**29,35**
Scenario 1	mean	-1258	3862	-2794	190	61,9	39,2	62,6	43,6	4372	28,36
Scenario 2	mean	-1269	4202	-3155	222	62,6	39,7	61,9	43,8	4697	29,1
Scenario 3	mean	-1194	2867	-1686	14	62,6	37,8	66,2	42,4	3360	30,3

The reference scenario corresponds to what was observed in November 2016.

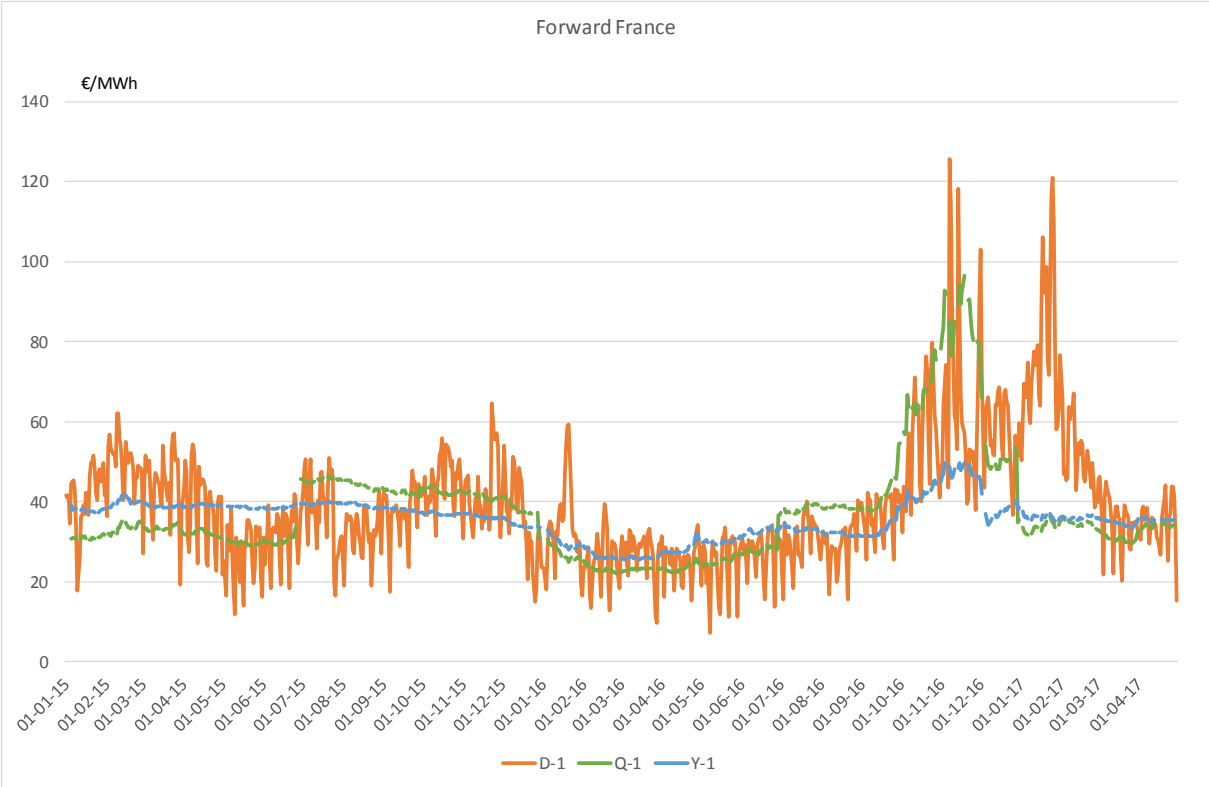
Scenario 1 shows the huge impact of the use of seasonal Fmax reflecting winter conditions on the prices and the exchanged volume.

In Scenario 2, without internal CBCOs of Amprion, monthly averaged CWE cross-border trade would have been 4697 MW compared to the recorded average of 3694 MW, an increase of 1003 MW or 27%. French import increases by 1078 MW and the French-German price spread decreases by 4,8 €/MWh. The variation of the price spread shows a huge impact on the relative competitive positions of the two countries.

The impact of the increased flow based domain is larger for France and Germany than for Belgium and the Netherlands. While German export and French import are boosted, Dutch export and Belgian import increases only marginally. This distributive may be a consequence of flow factor competition, which, as discussed in §3.1.1.4, grants – in the case of a mix of small and large bidding zones - in a FB environment a structural advantage to large zones because the latter have, on average, lower zone to zone PTDF [3]. Note that the effect of the flow factor competition is masked in the case of LTA-inclusion since the latter alters the PTDF-values and/or RAM-values on the constraining CBCOs.

Scenario 3 considering a use of Belgian PSTs for the limitation of loop-flows through Belgium has a negative impact on trade volumes and prices. This can be explained by the fact that loop-flows pushed out of Belgium overload network elements located elsewhere, and especially Amprion internal CBCOs. As the use of these internal CBCOs is challenged by CREG, the impact of this measure without taking into account the limitations linked to these internal CBCOs can be examined. This result shows the importance of the coordination in the management of congestions. This issue is further discussed in Chapter 5 below.

The impact of the import restriction due to CBCOs located inside the Amprion area on the French and Belgian day-ahead (D-1) prices was reflected in the forward prices in October and November 2016 as shown in Figure 11. The increase of the forward Y-1 at the end of 2016 is rather surprising. Such an increase is not expected in the case D-1 prices follow the normal and expected seasonal variation. Of course, the increase of this Y-1 forward price may be due to many other reasons and the contribution of the added CBCOs to this increase, is difficult to assess separately.



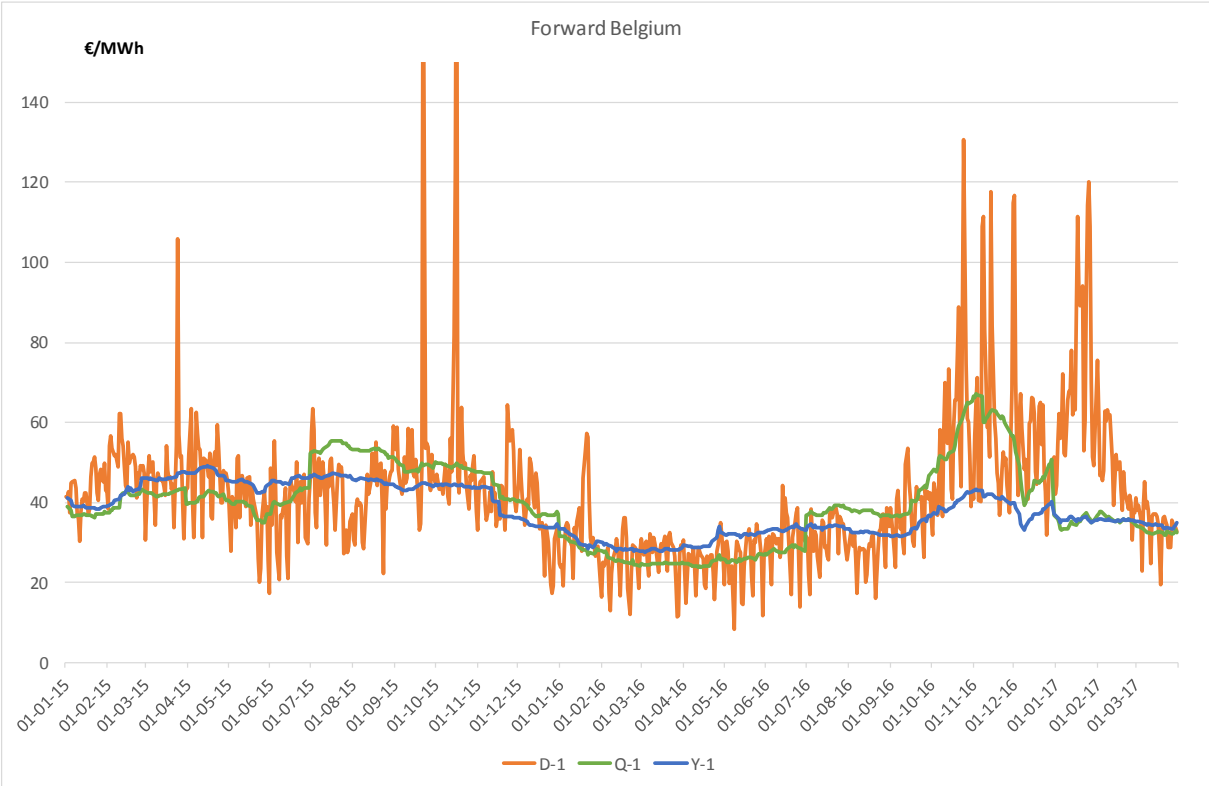


Figure 11 : Evolution of day-ahead (D-1), quarter-ahead (Q-1) and year-ahead (Y-1) wholesale electricity prices in France (top) and Belgium (bottom).

CWE TSOs presentation at the CWE Consultative Group meeting of the 28th of February, Brussels

CWE TSOs and PX performed an analysis of the impact of the added CBCOs after go-live since the start of FBMC. They simulated the market coupling without the CBCOs added after the parallel runs and compared the resulting Net Exchange Positions and market clearing prices with the historical values.

The analysis presented at the CWE Consultative Group meeting [11] shows that the added CBCOs have significantly reduced the Flow Based domain and have increased the number of empty domains or "pre-congested cases" (hours with no commercial capacity available for cross-zonal exchange).

The realized benefit of FBMC was almost half of what could have been realized without the addition of these new CBCOs after go-live: the expected welfare increase of FBMC compared to an ATC allocation was equal to 170k€/day in the simulations without the added CBCOs. By the inclusion of the CBCOs added after go-live that figure was reduced, on an average daily basis, by 87k€/day, with the welfare decrease being largest on winter weekdays (-155k€/day) and summer weekdays (-123k€/day). Approximately half of the expected welfare of the CWE FB market coupling, after 8 years of efforts, disappeared by the addition by Amprion of a few internal lines just after the go-live.

The promised welfare increase, combined with a better price convergence resulting of the parallel runs has played a great role in CREG decision for the approval of the implementation of CWE FB MC in April 2015, despite the many non-compliances of the method [5]. CREG, and the other NRAs, were clearly poorly informed on the benefits linked to flow-based.

The impact of the addition of these CBCOs on the prices, on average for the period July 2015 - July 2016 was also presented at the CWE Consultative Group meeting and was estimated, on average:

- BE: + 1.12 €/MWh
- DE: - 0.61 €/MWh
- FR: + 0.53 €/MWh
- NL: + 0.52 €/MWh

Such a structural change in day-ahead price is reflected in the forward markets and intraday market. For Belgium, with an annual national electrical consumption of about 84 TWh, the direct extra costs for consumers linked to this single measure of Amprion, can be approximated to 94 M€. For France and the Netherlands, with a national electricity consumption of respectively 483 TWh and 115 TWh, the direct extra consumer costs rise can be approximated to 256 M€ and 60 M€ respectively. In the German bidding zone, by contrast, where the annual electrical consumption is 628 TWh, direct consumer costs decrease can be approximated to 383 M€.

3.4. PROLONGATED USE OF POSITIVE FAVS ON CROSS-BORDER LINES

3.4.1. Discretionary actions

The use of 'Final Adjustment Values' (FAV) is a discretionary power of TSOs providing the TSOs the possibility to explicitly increase or decrease the available transmission capacity on both internal or cross-border lines. The CWE FBMC Approval Package specifies the following reasons and conditions for applying an FAV ([4] §4.1.4):

- *A negative value for FAV simulates the effect of an additional margin due to complex remedial actions (RA) which cannot be modelled and so calculated in the Flow Based parameter calculation. An offline calculation will determine how many MW can additionally be released as margin; this value will be put in FAV.*

- *A positive value for FAV as a consequence of the verification phase of the Flow Based domain, leading to the need to reduce the margin on one or more CBs for system security reasons. The overload detected on a CB during the verification phase is the value which will be put in FAV for this CB in order to eliminate the risk of overload on the particular CB.*

Any application of FAV must be documented, explained and communicated to all TSOs and NRAs. They are reported in the NRA monthly reports. It should be understood that the use of positive FAV should be exceptional, decided on a case by case basis and not ex-ante, for several months.

To sum up, exceptional positive FAVs were considered, but bilateral ex-ante FAV for several months were never imagined.

Amprion has breached the spirit of this rule, namely that an FAV should remain an exceptional measure to be applied in case of grid security concerns during the FB verification phase: from 29.05.2015 (a few days after go-live) to 02.09.2016, Amprion applied a constant positive FAV of 300 MW on all cross-border lines with the Netherlands:

- XB Sierdorf – Maasbracht : FAV + 300MW
- XB Rommerskirchen – Maasbracht : FAV + 300MW
- XB Gronau – Hengel SW : FAV + 300MW
- XB Gronau – Hengel WS : FAV + 300MW

During these 14 months, the interconnection capacity between the Netherlands and Germany has been reduced with a constant total value of 1200 MW.

In August 2016, in response to increasing pressure by other CWE TSOs, Amprion started to gradually decrease these FAV values by 50 MW/month. By December 2016, the FAV-values had dropped to 50 MW and since January 2017 they have been removed completely.

According publicly available information, the introduction of the FAVs on 29 May 2015 has not been announced to the market. No TSO Market Message on the JAO platform was found. The gradual decrease of 50 MW/month since 3 September 2016, by contrast, was timely announced on JAO.

3.4.2. **Impact**

The average characteristics and occurrences of all active cross-zonal CBCOs for the period June 2015 till December 2016 are shown in Figure 11 below.

The 4 cross-border lines between Amprion and the Netherlands have constrained cross-border trade for a total of 1805 hours. This is equivalent to 19% of all congested hours in this period (9283 congested hours) and 13% of all hours (14185 hours). Congestion on these cross-border CBCOs occurred mainly during the hours that Germany and France were exporting to the Netherlands and Belgium (952 of 1805 hours) or during the hours that Germany was exporting to the three other zones (568 of 1805 hours). On average, the FAVs represented a restriction of the feasible cross-border exchanges between 1048 MW to 1267 MW for the CWE region. Associated shadow cost were 50€/MW on average.

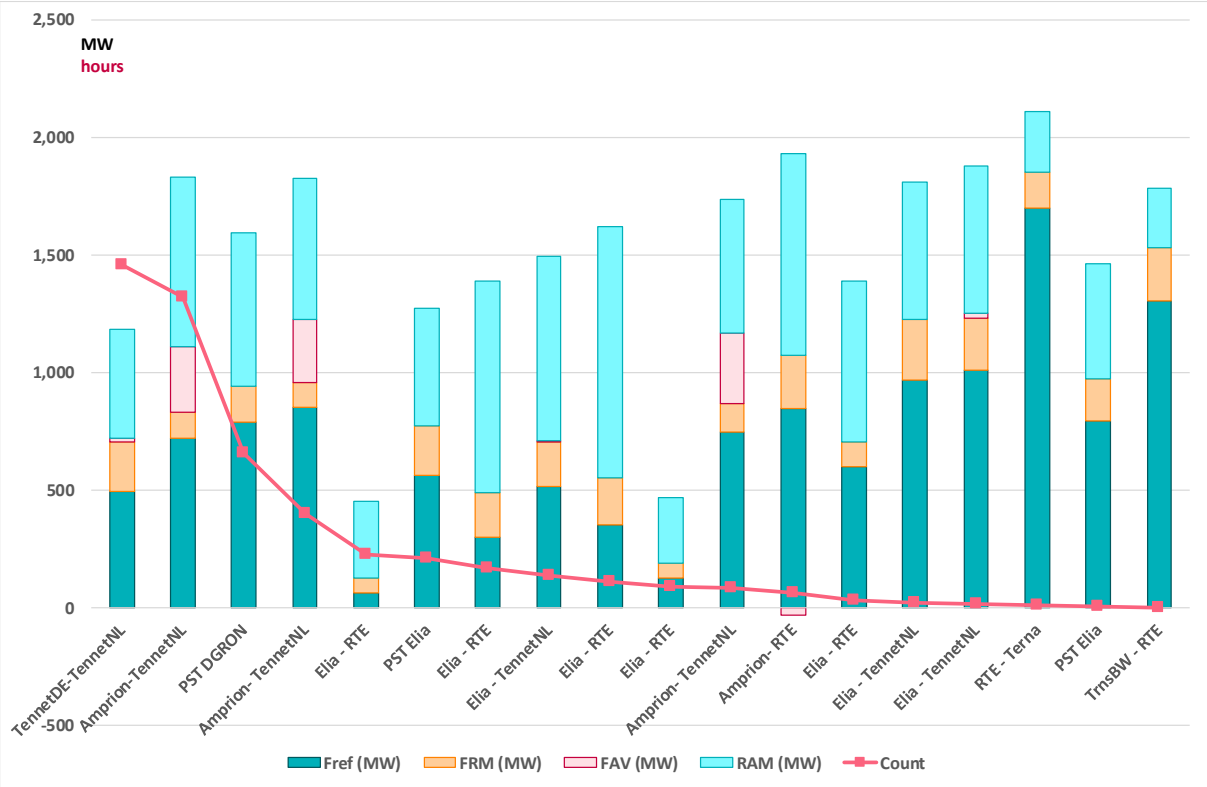


Figure 12 : Average characteristics and occurrence of cross-border critical branches when active. The height of the bar corresponds to the average line capacity, i.e. the thermal line capacity (Fmax). RAM, Fref and FRM values are also presented. On some cross-border lines, the RAM was further reduced or increased by a positive or negative Flow Adjustment Variable (FAV). Source: Data from CWE TSOs, post-processing by CREG

3.5. PROLONGATED USE OF SUMMER LIMITS FOR FMAX

3.5.1. Discretionary action

Most TSOs adapt Fmax on a seasonal basis, but some TSOs keep in the winter the same value as in the summer. Given that thermal limits can be up to 15% higher (and more) in winter than in the summer, failing to update the Fmax values for winter conditions means a significant reduction of available transmission capacity.

On September 20, 2016, RTE, Elia and Tennet NL have published the dates for application of seasonal limits. No information was published by German TSOs.

Based on the monitoring data, RTE, Elia and Tennet NL pursue the most dynamic approach. The Fmax values are updated on a seasonal basis. Winter values applied by Elia are 12% higher than summer values. In parallel, Elia is building up experience on the use of Dynamic Line Rating to enable daily and even hourly updates of Fmax. German TSOs, by contrast, have kept summer limits on most critical branches over winter 2015-2016, amongst which the four most constraining CBCOs.

Only at the end of November 2016 – upon pressure set by other CWE TSOs given the stressed situation on the electricity markets – Amprion decided to apply winter limits on some (not all) of its lines.

3.5.2. Impact

Simulations performed for November 2016 by CWE TSOs upon CREG request, indicate a major impact of the prolongated use of summer limits on the Amprion lines (see Scenario 1 discussed in §3.3.2). The simulations evaluate the historical market results for November 2016 if Amprion had applied winter limits instead of summer limits.

The CWE market situation in November 2016 was very stressed. It was characterized by high price spreads (monthly average of 29.3 €/MWh), high occurrence of price spikes (BE DAM and FR DAM prices exceeded 100 €/ MWh in resp. 8% and 7% of hours) and low CWE cross-border exchange (monthly average of merely 3694 MW).

The application of winter limits by Amprion in November would have significantly increased the flow based domain and the volume of CWE cross-border exchanges:

- On average, CWE cross-border exchanges would have been 677 MW higher, i.e. 4372 MW instead of the recorded 3694 MW (+18%).
- On certain hours, cross-border exchanges would even have been up to 5062 MW higher, namely 7213 MW instead of the recorded 2501 MW (+235%).
- The increase in cross-border exchanges would have been the largest during the morning (6am – 9am), the late afternoon (4pm – 5 pm) and the evening (9pm – 10pm).
- The average maximum price spread within the CWE region would have decreased by 1€/MWh, i.e. from the 29.35 €/MWh recorded to 28.36 €/MWh. Price spikes would still have been observed, however (still loop flows).

France was the most impacted by the prolongated use of summer limits in the Amprion area:

- French average net import position in November 2016 would have been 2794 MW instead of 2077 MW (+35%).
- French average day-ahead price would have been 62,6€/MWh instead of 65,2€/MWh. This means that this single discretionary action of Amprion had an impact of 3,5€/MWh on the average French price of November 2016.
- The monthly average price spread with Germany would have been 23.4 €/MWh instead of 27.0 €/MWh.

3.6. EXTERNAL CONSTRAINTS

3.6.1. Discretionary action

External constraints are explicit constraints on the net import and/or export position of a bidding zone. They come on top of the set of CBCOs network constraints and their introduction in FBMC is aimed to capture all issues related to grid security which go beyond the monitoring of the active power flows resulting from the DC load flow calculation in FB.

In the CACM Guideline (entered into force after the CWE go-live), Article 23.3 on external constraints specifies that "*If TSOs apply allocation constraints, they can only be determined using: (a) constraints that are needed to maintain the transmission system within operational security limits and that cannot be transformed efficiently into maximum flows on critical network elements; or (b) constraints intended to increase the economic surplus for single day-ahead or intraday coupling.*"

Following TSOs proposal of the CWE FB Approval package ([4] §4.1.9), external constraints can be included for two reasons. First, to avoid market results which lead to stability problems in the network (voltage stability, dynamic stability), detected by system dynamics studies. Second, to avoid market results which are too far away from the reference flows through the network in the base-case. The value is typically constant over the day, and determined by the TSOs individually.

In their Position paper, CWE NRAs required a justification of the proposed external constraints, not later than 9 months after the go-live, and indicated that, on the basis of the explanation provided by the TSOs, NRAs may decide to adapt or remove the external constraints. TSOs delivered the required studies approximately one and a half year after go-live.

The first possibility, in line with CACM text, was used by Elia and Tennet. The values are determined by offline AC load flow calculations and defines the net import position at which voltage stability issues may start to occur. Today, Elia applies a limitation of 4500 MW more in line with the import capabilities of the Belgian transmission system (several studies were performed on this issue). No export limitations are considered by Elia and Tennet.

The second possibility was used by the German and French TSOs. On the basis of the description provided in the approval package, this second possibility corresponds to the application of old NTC principles and is, according to CREG, not in line with CACM regulation.

RTE applied both import and export constraints for their bidding zone until August 16th 2016. On August 16th 2016 RTE removed the export constraint (FR_export) on CRE's request. The import constraint (FR_import), based on offline load flow calculations, has been applied during the entire monitoring period (June 2015 – December 2016) covered in this study. Note that since 13th of April 2017, RTE removed import constraints as well.

German TSOs apply an export constraint (DE_export). The justification provided is that it prevents the net position to deviate too much from the expected flows. BnetzA has asked German TSOs to justify the values used.

The value of the external constraints is typically constant over longer time frames. Minimum and maximum values encountered in the period of June 2015 to December 2016 are listed in Table 3.

Table 3 : Number and value of external constraints having been active in the period June 2015 – December 2016

External constraint (E.C.)	# active hours	Max value E.C. (MW)	Min value E.C. (MW)
DE_export	379	7,000	5,600
FR_import	274	8,047	1,801
NL_import	107	5,000	4,250
BE_import	91	4,500	3,250
FR_export	73	7,346	3,151

The observed minimum value of 3250 MW for Belgian import, applied by Elia on the 26sth of August 2015, was justified by Elia by an outage/maintenance on a PST in Zandvliet. Afterwards, during September and October 2015, values of 3500 MW and 4000 MW were applied, also for grid maintenance reason. Mid-October 2015 the situation went back to the value of 4500 MW justified by AC load flow calculations for voltage stability reasons.

Recently, in their proposal for the calculation of transmission capacities to be applied in the future for the CORE region (old CWE and CEE regions together), RTE and the German TSOs have no external constraint anymore, meaning that the German TSOs have also removed their external constraints.

3.6.2. Impact

From June 2015 to December 2016, external constraints have limited the FB domain in 8% of congested hours (924h). Figure 13 shows that German export constraints (41%) and French import constraints (30%) are the most frequent.

External constraints are only active when the exchanged CWE volumes are relatively high. For the given monitoring period, their associated shadow costs were relatively low, ranging from 10€/MWh (Belgian import constraint) to 5€/MWh (German export constraint).

The impact may have been larger in terms of occurrence and/or shadow cost if the size of the FB domain would not have been so often and heavily reduced by the inclusion of highly loaded internal CBCOs, positive FAVs and loop flows. Therefore, even if less impacting than the other TSO discretionary actions, TSOs should be able to provide verifiable calculations for the external constraints applied.

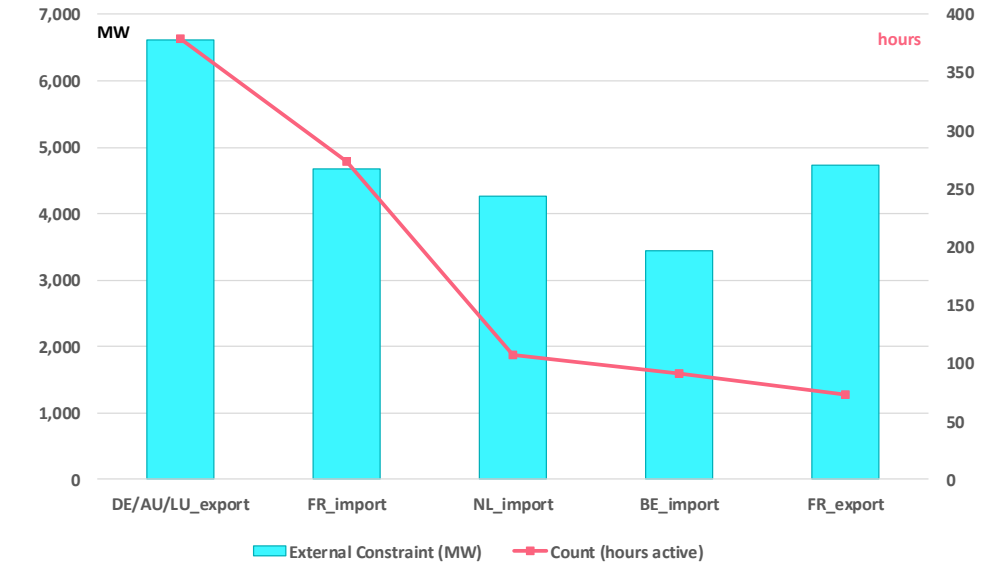


Figure 13 : From June 2015 to December 2016, External constraints have limited the FB domain in 8% of congested hours (924h), of which the majority being German export constraints (41%) and French import constraints (30%).

3.7. LAGGING BEHIND ON MARKET TRANSPARENCY

3.7.1. Discretionary actions

With ATC, calculation of transmission capacity was clearly separated from the market coupling and provided per border. In addition, TSOs were (and still are) obliged to publish the unavailability of important transmission network elements with significant cross-border impact. As a consequence, market participants were able to estimate precisely the capacity available for cross-border exchanges on a given border taking into account announced unavailability.

With FBMC, calculation and allocation of transmission capacity is done at the same time, so market participants do not know in advance the available cross-border capacity for commercial trade. On top, the limitation of cross-zonal capacity can be caused on other CWE borders or inside other zones (i.e. on any of the CBCOs introduced by CWE TSOs).

In other to achieve the same level of transparency as with ATC, it is essential that markets participants are informed of the (names of) critical network elements limiting the transmission capacity and of the

availabilities of these network elements. The more information, the more market participants can relate the CBCO-data with the underlying physical reality – and properly anticipate. Transparency implies both detailed information on a daily basis and appropriate notification on specific events:

- Information on a daily basis is published in the JAO utility tool [6]. Market participants can extract all information on the hourly CBCOs (CBCO IDs, PTDFs and RAM) and the resulting flow based domain (min-max bilateral exchanges and min-max net positions) for D+1.
- Special events or discretionary actions which impact commercial capacity with more than 100 MW, are to be timely communicated to market participants on a central transparency platform – as required by REMIT.

Five major cases of TSOs discretionary action resulting in a lack of market transparency were observed.

Transparency on CBCO location (non-anonymized IDs and consistency in naming)

Since the beginning of the implementation process of FB in the CWE region in 2009, most or all (depending of the period) NRAs were supporting full transparency on these network elements.

It is clear that full transparency is only possible if the reference to the critical network element is not anonymized, to the contrary to what was proposed by some TSOs (Amprion) for reasons of possible interaction with the critical infrastructure directive (DIRECTIVE 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection).

RTE, Elia and Tennet NL decided in September 2016 to publish the names of their CBCOs. The publication of the names of the CBCOs on JAO was much more difficult for German TSOs, which finally accepted to publish the names (non-anonymised information) of their CBCOs only in June 2017.

Transparency also requires that information is provided in a correct and coherent way. In general, market participants criticized the lack of consistency in the CBCO-naming.

Transparency on critical outages

In December 2016, market participants condemned the lack of transparency on critical outages, especially on internal lines in the DE/AT/LU bidding zone: '*We had a glaring example in March, when the TSOs, asked on the Q&A forum about some days with a strange relationship between German and French prices, replied "During the period which you are referring to many different grid elements, which are in the same area as the concerned CB is located, were out of service in different time", but no outage was published neither in the Transparency Platform nor on individual TSOs' websites.* '

Market participants tackled the lack of harmonization for the DE/AT/LU bidding zone, urging German TSOs to adopt the same transparency standards as Tennet DE, RTE and ELIA who publish detailed REMIT messages.

Transparency on the introduction of new CBCOs

In summer 2015, just after go-live of FBMC, Amprion introduced (at least 4) internal critical branches to the CBCO-set which were not in the CBCO-set included in the parallel runs. This action – with major market impact - has not been communicated to the market. It was even not explicitly communicated to NRAs.

Transparency on the introduction of positive FAVs on cross-border lines

In summer 2015, Amprion introduced positive FAVs (+300MW) on all interconnectors between its control area and the Netherlands. This was not communicated to market participants (and again not explicitly communicated to NRAs).

Transparency on the use of seasonal thermal limits for Fmax

German TSOs do not publish information on the application of seasonal limits for Fmax, in contrast to Elia, RTE and Tennet NL – despite explicit request from CWE NRAs and market participants.

Transparency on the value of external constraints

On August 26th, 2015, Elia changed the Belgian import limit from 4500 MW to 3250 MW (see section 4.6.1). A market participant complained that this action was not properly communicated to all market participants. This claim is now being investigated by the CREG in the framework of REMIT. Note that Belgian import constraints have been lower during 2 consecutive months because of grid infrastructure works (3500 MW until September 22nd of 2015 and 4000 MW until October 18th 2015).

3.7.2. Impact

Lack of transparency has resulted in distrust by market participants on the functioning of CWE FBMC. Market participants pinpointed not only the high occurrence of hours with limited cross-border commercial capacity, but also the lack of understanding of how this is related to the grid situation. They are not able to relate the observed cross-border exchange capacities to a physical reality and thus to appropriately anticipate the market outcome.

The introduction of FBMC in the CWE region may be one of the reasons affecting liquidity on the day-ahead market, Traders have been struggling to predict day-ahead exchange prices under the new method. In 2016, German day-ahead volume dropped 11% at the EPEX spot exchange and 20% on the over-the-counter (OTC) market compared to 2015.

The lack of information can also have an impact on the short term operational security. In the winter 2015/2016, Belgium alone was able to import more than 4000 MW alone. In 2016, in November, due to a new (exceptional) generation pattern, with simultaneous imports for Belgium and France, Belgium imports were limited very often in the day-ahead market coupling to 2000 MW. It is assumed that this import limitation was difficultly foreseeable for Belgian producers which may have kept several units idle due to a lack of competitiveness and rely on imports.

3.8. COMBINED IMPACT ON CWE CROSS-ZONAL EXCHANGE

In the former sections, it was attempted to isolate and quantify the market impact of specific TSO actions. In this Section, the cross-zonal exchanged volumes before and after the implementation of FBMC are presented, englobing the combined impact of all of these actions and other factors on the overall performance.

Of course, all performance analysis should be done within the market context. Especially with FBMC, where capacity calculation and allocation are implicitly defined through the optimization algorithm, it is hard to distinguish between the impact of the management of congestions by the TSOs through FBMC, as reflected in the CBCO data set provided by the TSOs, and the impact of the evolution of market conditions and requests, as reflected in the bids of market participants. Nevertheless, the impact of network constraints can clearly be observed from a comparison of cross-zonal exchanges before and after introduction of FBMC, especially when focusing on congested hours.

CREG computed the volumes exchanged in the CWE region between the four bidding zones since the beginning of the CWE market coupling end 2010. CWE cross-zonal commercial exchange is defined as

the sum of Net Exchange Positions of all exporting zones. The volumes represented in this section include also the netted sum of the long-term nominations[6].

Figure 14 below shows the monthly average of CWE cross-zonal exchanges since the introduction of FBMC in May 2015. Volumes exchanged have decreased, despite persisting high price spreads. The first months of FB the cross-zonal exchanges seemed promising, with volumes being significantly higher than with ATC. But from September 2015, the exchanged volumes dropped significantly due to the addition of a few new internal critical branches in the Amprion area, as indicated by the TSOs themselves in their presentation made at the Consultative Group Meeting the 27th of February 2017 in Brussels [11]. This reduction persisted until the end of the monitoring period, i.e. December 2016. The exchanged volumes are on average 900 MW lower than in 2014 with the ATC capacity calculation method.

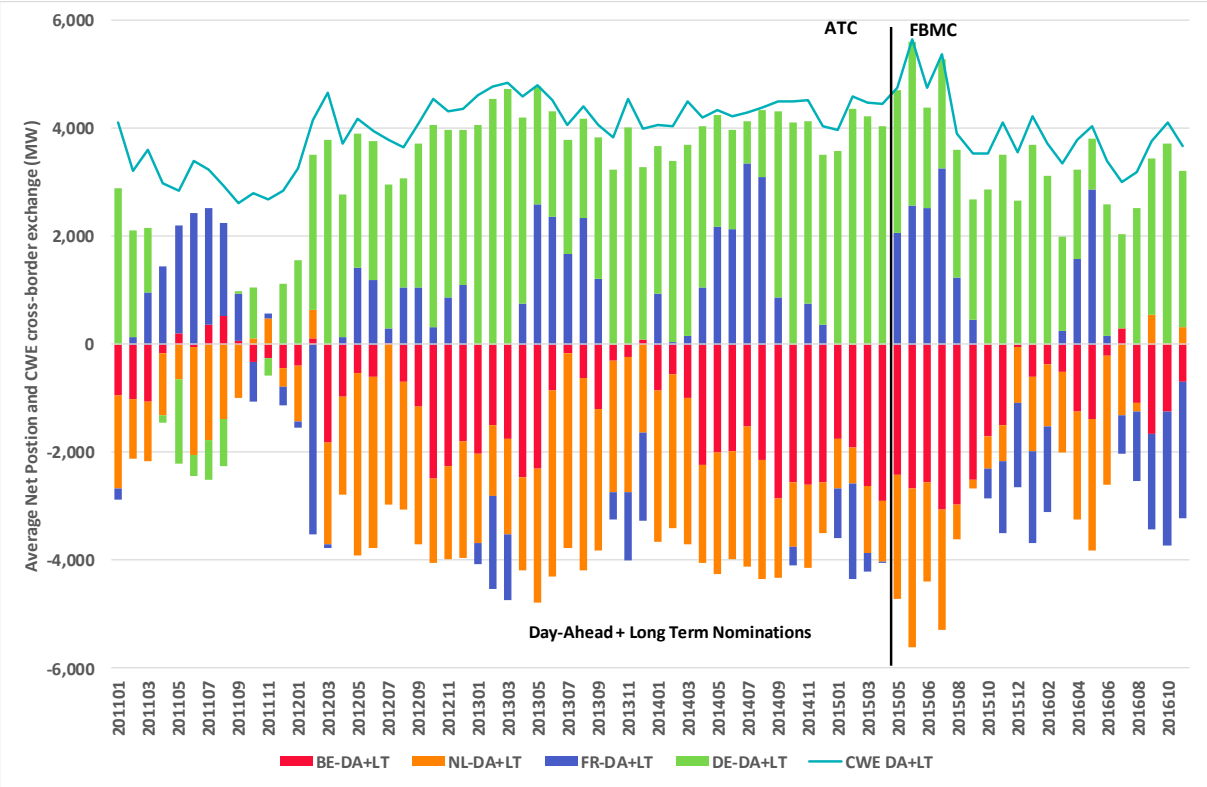


Figure 14: Monthly averaged Net Positions and CWE cross-zonal exchanges in day-ahead + long-term before and after introduction of FBMC on 21/05/2015. The Net Positions are represented by the bars, the CWE cross-zonal exchange by the blue line on top. Source: CWE TSOs, CREG

Figure 15 below shows the evolution on the recent years of the yearly average of cross-zonal CWE exchanges for the congested hours only. In 2016, the yearly average of CWE cross-zonal trade during congested hours was 3700 MW, a decrease of 900 MW compared to 2014. Yearly averaged CWE cross-zonal exchanges in day-ahead remained at the same level as previous years, i.e. about 3500 MW, and has not compensated the reduction of long-term nominations due to a reduction in the volume of

[6] Combining day-ahead cross-zonal volumes and long-term nominations improves the fairness of the evaluation of the evolution of cross-zonal exchange over time since the total sum does not depend on the value of long-term allocated rights (which vary from month to month) and does not depend on the type of long-term transmission rights (physical versus financial transmission rights). Exchanges in intraday have not been taken into account since not all CWE-border nomination data are available yet. Their contribution in the total cross-zonal trade has been minor up to now.

long-term capacities made available to the market on some borders and to the shift from physical to financial transmission rights at the Belgian borders (which require no nominations).

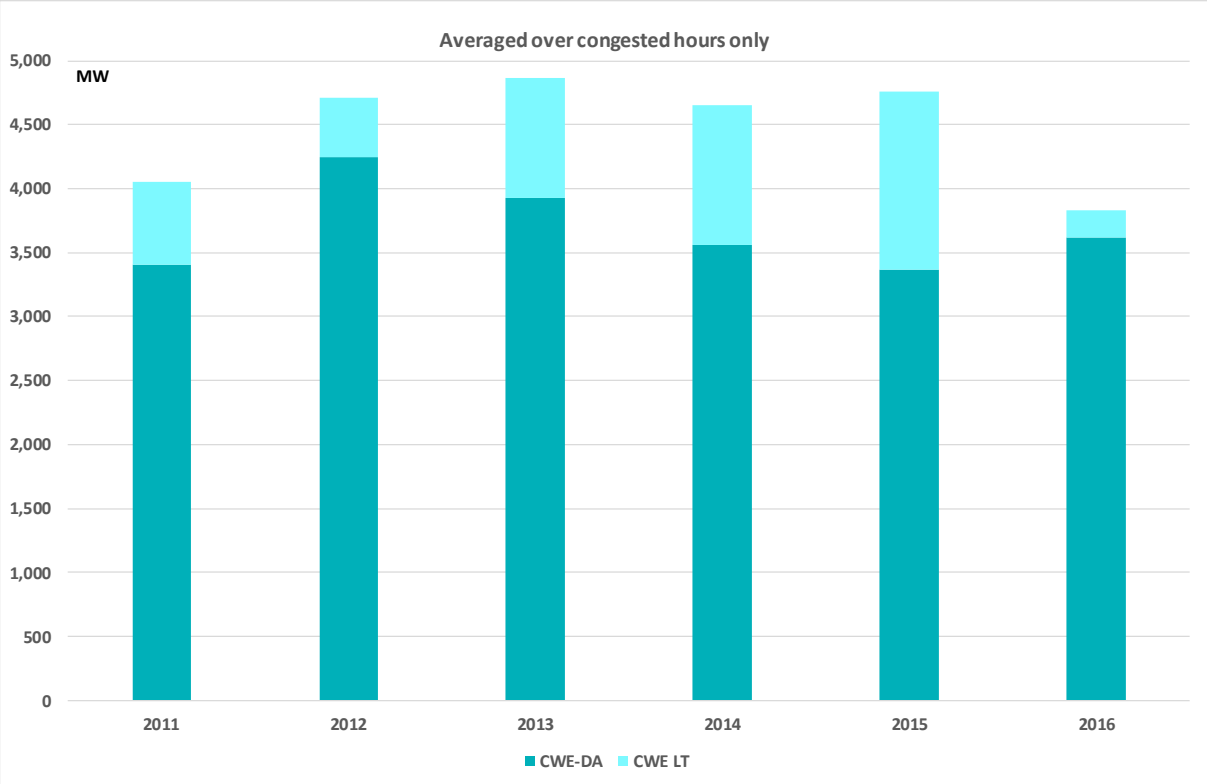


Figure 15: 6-year evolution of CWE cross-zonal exchange on the long-term (LT) and day-ahead (DA) market against the average maximum price spread within the CWE region, evaluated for all congested hours.
Source: CWE TSOs, CREG

The hourly values of CWE cross-zonal exchanges, shown in Figure 16 below in function of the maximum hourly price spread between the four bidding zones show that FBMC can outperform ATC and lead to higher cross-zonal exchanges. The graph shows the netted day-ahead and long-term exchanges on CWE borders during congested hours. In October, November and December 2016 maxima of more than 8800 MW were recorded, whereas the maximum volume recorded with ATC was 7023 MW, in July 2012.

On the other hand, that figure also shows that cross-zonal exchanges were often below the typical values of ATC. In 24% of the hours, volumes exchanged with FBMC were below the 10% percentile value of 3351 MW with ATC. In 17% of the hours, the volumes exchanged with FB MC were below the 1% percentile value of 2601 MW with ATC. At hours with high price spreads, the volumes exchanged with FBMC are in the range of 1000 MW lower than with ATC. The frequency of hours with high price spreads also increased. Note that hours with price spreads above 200€/MWh are not displayed.

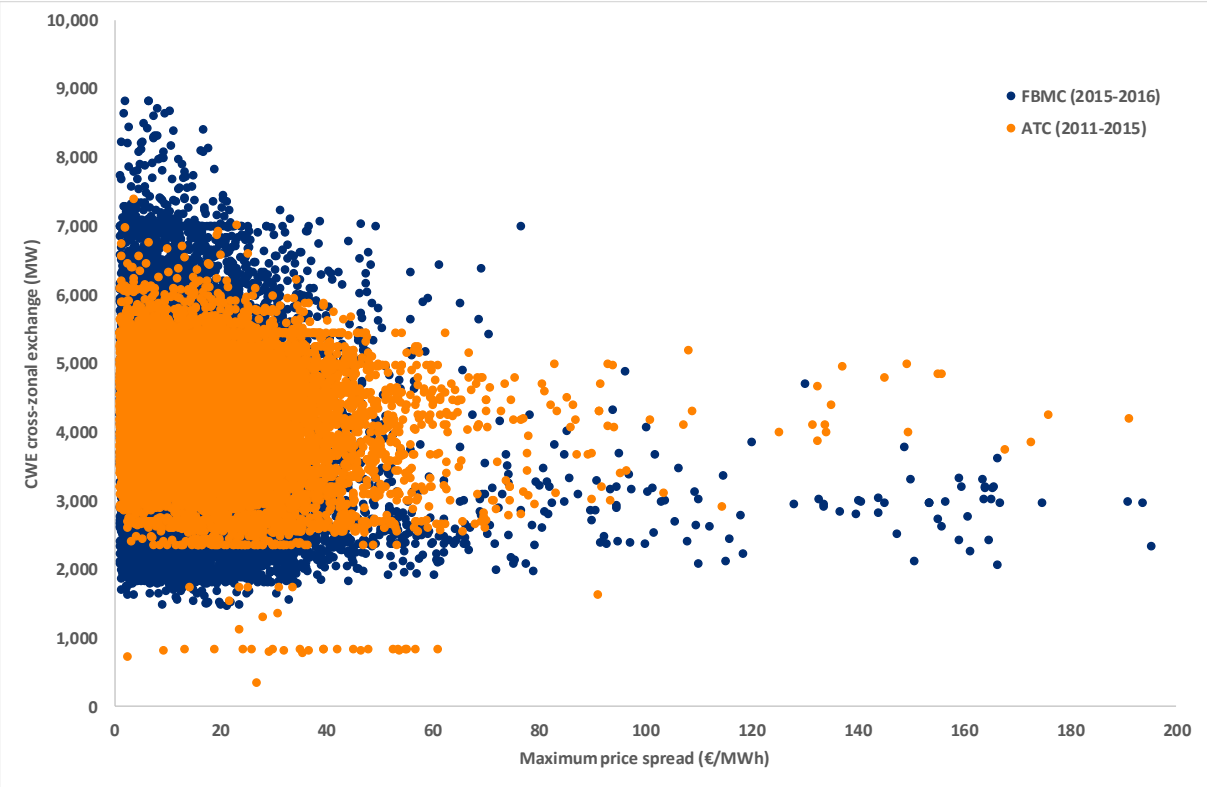


Figure 16: Hourly values of CWE cross-zonal exchanged volumes (DA + LT) in function of the maximum price spread before and after introduction of FBMC. Hours with price spreads higher than 200 €/MWh are not shown.
Source: Data from CWE TSOs, post-processing by CREG

The most striking illustration of the failure of the current CWE FBMC implementation may be the number of LTA violations presented on Figure 17 below. This slide is copied from a presentation made by CWE TSOs to the CWE stakeholder forum of the 27th of February 2017 already mentioned. Since the go live, the triggering of the LTA patch increased from 7%, based on parallel run estimations, up to 70% on average at the end of 2016, which means that 70% of the time, the FB MC coupling behaved like an NTC market coupling based on LT rights. These LT rights were coordinated at CWE level and correspond for the Belgian borders to values equal approximately to 33% of the NTC values. This clearly shows the failure of the FB implementation which nails down to a mix of a FB allocation based on artificial, virtual CBs safeguarding old NTC values.

Capacity calculation improvements

Flow based Day Ahead pre-congested capacities (4/4)

Evolutions of LTA violations for likely corner since June 2015:

- The LTA violation indicator illustrates the percentage of hours when LTA inclusion is activated for the likely market directions

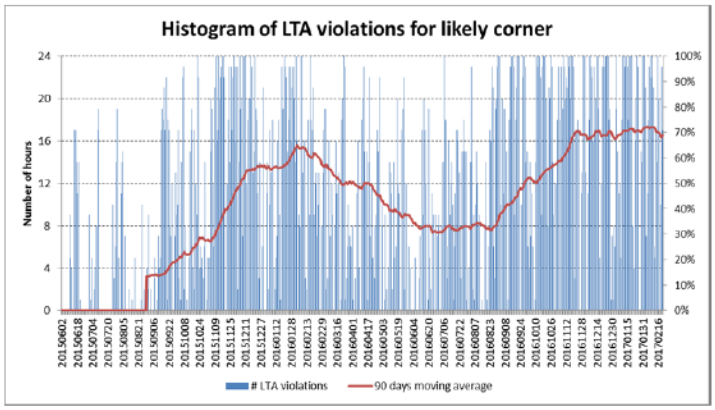


Figure 17 : Evolution of LTA-violation since the start of FBMC (monitoring results since June 2015). Source: [11]

4. CONSEQUENCES OF THE CURRENT SITUATION

Belgian, French and – to a lesser extent - Dutch customers, suffer substantial direct and indirect economic losses linked to the current design and implementation of day-ahead market coupling (reduced import capacity, reduced competition and/or threatened security of supply). German customers, on the other hand, incur high grid tariffs, resulting from the socialized costs of re-dispatching within the German bidding zone. This chapter, investigates possible drivers for maintaining the current situation and discusses the consequences of curtailing cross-border trade from a TSO perspective.

Firstly, Section 4.1, examines the consequences of an ineffective flow-based market design and an inadequate choice of bidding zones delimitation. They may be linked to the following:

- Favor incumbent producers through more re-dispatching, possibly incentivized by a partial unbundling of the TSO and the incumbent producer,
- A strong distributive effect in favour of producers and reduced competition because of the preference to implement a congestion management system based on re-dispatching which, in addition to being less efficient than a well-designed market coupling,
- favor investments in transmission networks instead of market design improvements a perverse incentive linked to the regulated asset based remuneration of TSOs applied in several CWE countries.

Secondly, Section 4.2 and 4.3 examine the consequences of limiting cross-border exchanges. The main consequences identified are:

- A reduction of re-dispatching costs, which means lower network tariffs for national consumers,
- A reduction of re-dispatching needs, which means operational security is easier to achieve for TSOs, hence lowering their risk and increasing their risk-adjusted return on equity,
- Less export, which – for an exporting country - means lower wholesale price for the national industry, favouring national market players.

Finally, Section 4.6 highlights the possible analogies with the consequences of the behavior of Svenska Kraftnät, the Swedish TSO, between 2002 and 2008, of pushing congestion internal to Sweden to the Swedish-Danish border.

Finally, it is important to note the role played by existing power exchanges for keeping the current bidding zone configuration unchanged as in the case of a “technical” split combined with the creation of a hub covering several bidding zones, the liquidity of a national hub does not necessarily belong anymore to the same NEMO and consequently will lose these revenues.

4.1. OLD INCUMBENTS FAVORED

Before liberalisation, some form of central dispatch combined with re-dispatching was the normal wy for the management of congestions. The system was globally optimised (even transmission losses were taken into account at that time) and there was no issue with the distribution of the benefits of a better design between Member States or between producers and consumers. Uncertainty on the expected flows was minimal. Coordination, at the country level, was optimal.

The main goal of liberalisation was to put more competition, more pressure on producers for a better efficiency and better prices.

The market coupling, when applied to small bidding zones, is a powerful tool to achieve that goal, and to re-introduce some coordination in the dispatch. Re-dispatching is minimal in that case.

A model based on re-dispatching for the management of congestions in a liberalised market is totally different from the use of re-dispatching in a vertically integrated system. In a liberalized market, with different players, there is no automatic concern anymore for the global efficiency: the TSOs define the required volumes with some security margins and producers are happy if they are paid for their re-dispatching service (and there is also no concern in such a design with the externalities linked to such arrangement and the generated loop-flows in particular).

It is important to say that a model based mainly on re-dispatching for the management of congestions has never functioned properly in a liberalised environment. Many examples exists on the failure of this approach (Enron, DEC game,…). The recent request made recently by BNetzA for additional reserves (power plants) for congestion management is symptomatic of the non-efficiency of this approach.

The main problem with a generalised re-dispatching model is the support (distributive effect) provided by such a model to local producers and the reduction of competition in comparison with a market coupling.

With a market based congestion management (a market coupling), with sufficiently small bidding zones, congestions can be managed in an efficient, coordinated way, in two stages, with a day ahead market coupling (and in intraday, if a cross-zonal implementation exist), with competition between producers and consumers, and with residual congestions in real time.

But congestions can also be managed with the assumption of a copper plate in day-ahead, with the (bilateral) reservation by TSOs of large quantities of re-dispatch capacities (which may not be needed in real time), and with less coordinated activation of some of these units in case of congestions. This is the option based on re-dispatching.

For efficiency and competition reasons, the EU target model is based on the first option, ie. the concept of market coupling/market splitting.

This also raises competition issues between German producers, where re-dispatching payments come on top of the wholesale price, and other CWE producers, where re-dispatching is much more limited (a re-dispatching figure estimated at 911 million €/year (2015) or 600 million €/year (2016) leads to an additional payment of approximately 1.5 and 1 €/MWh on average for German producers).

So, the persistence of a congestion management design mainly based on re-dispatching favours producers – sometimes the old incumbent - and may result of a non-effective unbundling between TSO and generation activities.

The reduction of re-dispatching costs is given today by BNetzA as justification for the German – Austrian split.

4.2. RE-DISPATCHING COSTS REDUCED

Germany (DE/LU/AT) is a very large bidding zone with renewables concentrated in the North and demand concentrated in the South. Commercially, the DE/LU/AT bidding zone is considered to be a 'copper plate': transmission capacity constraints are not taken into account for domestic trade. This choice for a single large bidding zone however conflicts with the physical reality. The grid infrastructure, both inside and outside Germany, is not strong enough to transport all renewables from the north to the south. Commercial domestic trades – based upon the copper plate assumption – calls for curative congestion management actions by TSOs (re-dispatching mainly) to guarantee grid safety.

FBMC is the EU target model for congestion management. The CBCO-selection criteria define which transmission lines are managed by the cross-zonal FBMC and which (the residual congestions in the spirit of a zonal model) are managed by local congestion management tools such as re-dispatching.

The current 5% CBCO selection rule gives TSOs the opportunity to use the cross-zonal FBMC for congestion management on internal lines, even on (structurally) congested ones. This limits local re-dispatching needs at the expense of cross-zonal commercial capacity.

4.3. THE ACHIEVEMENT OF OPERATIONAL SECURITY FACILITATED AND RESERVE NEEDS REDUCED

In their answer to the CREG request for the neutralization of critical branches inside the Amprion area, the TSOs mention that "the operational feasibility cannot be guaranteed" if these internal CBCOs are excluded from the CWE DA Flowbased.

It is important to mention three issues here:

1. The choice for a congestion management model based on re-dispatching for internal lines is a choice made by the German/French TSOs. Other solutions exist, such as market splitting, but were never considered seriously.
2. The need for re-dispatching is driven by reasons internal to the German bidding zone (wind infeed) and has nothing to do with cross-zonal exchange which moreover only has a limited impact on these congestions (very low PTDFs – see Section 3.2)
3. A congestion management system based on re-dispatching cannot function – is not feasible -, and has never been implemented successfully anywhere in a liberalized environment, for many reasons, amongst which its feasibility and the sharing of re-dispatching costs.

A re-dispatching model in a liberalized environment is based on an artificial segmentation of the resources needed for the operation of an electric system. In electricity, the same power unit is able to (at the same time) produce electricity, manage congestions (if adequately dispatched), provide reserves (for balancing) (and also ramp capabilities and reactive power). A market coupling is a congestion management system which is able to combine at the same time the delivery of energy and the management of congestions. In a zonal market coupling model, the same unit delivers at the same time energy and solve congestions. No reservation of generation capacity is made for this objective of congestion management (the same reasoning applies to the importance of a move towards co-optimization of energy and reserves).

In a liberalized environment (non-vertically integrated), the TSO (for "security reasons") and the producer (for not losing money with this activity in comparison to a participation to the market) make arrangement on the (sometimes exclusive) availability of some resources in case of congestions. These units cannot participate in the generation of electricity at least for a part of their capacity. As congestions, may appear in many places, "reserves" must be put aside everywhere. The more the (day ahead) dispatch deviates from what is physically feasible (which corresponds today in situation with a lot of wind with priority dispatch), the higher the volume of reserves needed. "Good" TSOs applying this model will make sure that "enough" reserves are contracted, and a "liberalized" producer will not complaint to provide reserves for (inefficient) congestion management instead of delivering energy at least if they are (well) paid for it. Such a design will require that more reserves have to be put aside for guaranteeing the security of the system, and these needs may excess what is available even in a system with overcapacity.

The German system is a good example of this drift with the multiplication of reserves for re-dispatching, strategic reserves for congestion management, reserves for balancing and strategic

reserves for system adequacy. The need for new investment in reserve capacity – congestion management - was recently announced for meeting these requirements.

All this demonstrates that the management of congestions on these internal lines without the help of the cross-zonal FB MC may require capacity for re-dispatching which may not be available in the German system, seen the inefficient and segmented allocation of resources for the generation of electricity and the management of congestions.

4.4. THE JUSTIFICATION OF NETWORK REINFORCEMENTS FACILITATED

The implementation of more efficient congestion management methods reduces the need and thus complicates the justification of additional investments in the transmission systems.

Most of the TSOs of the CWE region are remunerated on the basis of their assets. This remuneration method may have the perverse incentive that more investments in transmission lines has a beneficial impact on the results of the TSOs.

More efficient bidding zones and especially the move to a nodal congestion management solution which may dramatically increase transmission capacities (recent calculation performed in the scope of the Flow Factor Competition study indicated that France and Belgium together should have been able to import together approximately 6000 MW more than the realised value for some days of November 2016). A more efficient congestion management method than today would lead to additional available transmission capacity with the *existing* assets and may therefore complicate the justification of new investments in transmission networks.

In this perspective, the benefits of massive North-South network reinforcements of the German grid can be compared to the benefits of a nodal implementation where the FRM on network elements is reduced from 12% on average to zero.

4.5. LOWER WHOLESALE PRICES FOR EXPORTING COUNTRIES

In a market coupling mechanism, by reducing the exports of an exporting country, TSOs de facto reduce the price increase of that exporting country.

The external constraints applied by German TSOs, the internals critical branches, the FAV and the generated loop flows have all resulted in a reduction of German exports and in a reduction of the German day-ahead clearing price relative to prices in neighbouring countries.

4.6. DISCUSSION: ANALOGIES WITH THE SWEDISCH CASE

The Swedish/Danish Oresund interconnector case of 2006 is famous in illustrating the huge economic impact of capacity allocation and congestion management practices. This case, which gave rise to the splitting of Swedish single-price zone into 4 price zones in 2010, showed that system operators can exert market power which can inflict high economic losses for market participants. This section introduces this case and highlights insights which are relevant as a reference for this study.

The Oresund interconnection, with a nominal capacity of 900 MW, connects southern Sweden with eastern Denmark. In Sweden, production mainly stems from hydro power plants located in the North and nuclear power plants in the South. Demand is concentrated in the South. In eastern Denmark, production mainly stems from thermal power plants. Demand is geographically spread.

Through the Oresund interconnection, Denmark can import (relatively cheap) hydropower from Sweden and thus limit generation from (relatively expensive) thermal power plants. As shown in the study of Copenhagen Economics, commissioned by the Danish TSO, this cross-border trade has a huge positive impact for the Danish consumers and a negligible impact for the Swedish consumers because of the respective marginal production costs. The Oresund interconnection capacity is large and the interconnection is rarely physically congested.

However, internal lines in Sweden between the hydro-production region in the North and demand-rich region in the South, are often congested. To avoid overloading of those lines, the Swedish system operator Svenska Kraftnät (SvK) had the practice – between 2002 and 2008 - to reduce the available capacity of the Oresund interconnection, as to reduce the export generated flows on her network.

SvK had obvious incentives to push internal congestion to the borders. First, the Swedish government was, at that time, not in favor of accepting different prices within its national borders. Second, cross-trading would be high since cheap hydropower in the North would have had to be replaced by expensive thermal power in the south. Third, the externalities caused by export restrictions were relatively small though positive for the Swedish consumers (since Swedish wholesale prices marginally decrease when export is reduced); while the highly negative externalities for the Danish consumers had not direct impact on SvK's operation.

In 2006, the Oresund interconnection case was brought to EU DG Competition by Dansk Energi, a commercial and professional organization of Danish energy companies operating in Denmark. In 2010 DG Competition judged the practice of "curtailment of cross-border transmission capacity for electricity by SvK to address internal congestion" was a case of abuse of market power, breaching Article 102 of the Treaty on the Functioning of the European Union.

In a preliminary assessment, the European Commission raised competition concerns based on the observation that SvK was curtailing interconnector capacity because of internal congestion problems. The Commission judged that, by doing so*, "SvK was treating domestic transmission services and transmission services to an interconnector intended for exporting electricity, differently, thereby impeding customers and producers from reaping the benefits of the IEM"*.

To address these concerns, SvK decided in September 2009 to subdivide the Swedish bidding zone into two or more bidding zones and to manage congestion in the Swedish transmission system without limiting trading capacity on the interconnectors.

As in the Swedish case, the TSO actions analyzed in this CWE DA FBMC study could be interpreted as pushing internal congestion to the border, or as favoring domestic trade to cross-border trade. The consequences on TSO operational level, such as reduced need for re-dispatching, or for national customers, such as reduced wholesale prices, are similar to the Swedish case as well.

5. WHICH REMEDY?

In the short term, a major revision of the CBCO-selection rule can help to alleviate the major problems observed in the CWE region today. By imposing minimum criteria on available RAM on the CBCOs managed by FBMC, the flow based domain will be enlarged and cross-zonal volumes increased. This is a direct way to halt the discrimination of cross-zonal trade in favour of domestic trade, since it imposes that the preloading of the network due to domestic trade is such that the "left-overs" for cross-zonal exchange are larger than what they are today.

In this context, CREG has proposed a new CBCO-selection method (Annex 1). The CREG proposal aims at providing a pragmatic approach to reach the European targets as recalled in ACER Recommendation 2016/02 [10]. The proposal tries to address the issues of inefficiency and discrimination without a redefinition of the bidding zones by removing highly preloaded internal CBCOs from FBMC and by imposing a reduction of generated loop-flows, even if such a solution may provoke high re-dispatching costs in large bidding zones and do not correspond to an enduring solution. The CREG CBCO-selection proposal is based on the observation that the debate on zonal configuration may not be solved quickly and constitute an attempt to internalise as much as possible in the countries at the origin of the problem the externalities they provoke.

It is important to recall that the continuation of the current situation is not sustainable, neither for Germany (with huge re-dispatching costs and the lack of re-dispatching capacities) nor for the other CWE countries (with reduced security of supply, reduced competition and with discrimination). The current market coupling design does not provide correct price signals for producers, consumers and infrastructure investments. A congestion management model based on the copper plate assumption and on generalised re-dispatching (as it is currently the case in DE/AT/LU) has never functioned properly in any country.

The only feasible, efficient and enduring remedy to the problems examined above is a split of the large bidding zones in smaller ones or the move to a nodal design (which avoids this complex step of bidding zone definition). Smaller bidding zones will not only solve discrimination issues between internal and cross-border trade, but will also increase available transmission capacities in the CWE region and hence increase the capacity for commercial trade. This will increase competition and lower prices for consumers in the CWE and (in the future Core) regions.

In this context, reference to the Swedish/Danish Oresund interconnector case of 2006, introduced in Section 4.6, is highly relevant. The European Commission considered that an appropriate configuration of the bidding zones was the only market-efficient solution for Sweden to solve its internal congestion problems, which gave rise to the splitting of Swedish single-price zone into 4 price zones in 2010.

To facilitate an open debate on bidding zone configuration, it is important to recall that several bidding zones only implies different prices for the generation side (which is already the case today with re-dispatching), and does not necessarily imply different prices for consumers (see the Nordic reference price, the Italian PUN price and, in the US, the free formation of hubs gathering a large number of nodes with similar prices). The CREG, however, has the impression, through informal contacts, that this so-called "technical zone splitting" (with one price zone but several bidding zones) has not been studied in detail in Germany. Also, a zonal splitting does not lead to a reduction of the liquidity of the organised markets or to increased market power. In the contrary, as cross-zonal exchanges have to go through these organised markets (the MCO is a monopoly by design), the higher the number of zones, the higher the volume of exchange obliged to transit, or to be managed by the organised markets (market-based allocation). The move to smaller bidding zones should also be accompanied by improved long-term transmission rights products, with zone to zone products, a flow-based allocation of these long-term rights (on the basis of the model proposed by ETSO in 2002) and obligations rights.

Adequately defined bidding zones will automatically lead to sufficiently high RAMs on the constraining network elements and, hence, will comply with IEM. If the German bidding zone is not split, having sufficiently high RAM on its constraining network elements in order to comply with the rules of the IEM will require large re-dispatching reserves and costs. The CREG doubts that re-dispatching can constitute an enduring solution in this regard. Moreover, large and frequent re-dispatching could in itself lead to inefficiencies, discrimination and unfair competition.

Whatever the outcome of the bidding zone review may be, it should be clear for everyone involved that it is impossible to comply with the rules of the Internal Electricity Market, if the CBCO-selection method allows low Remaining Available Margin (RAM), as today.

6. LIST OF DOCUMENTS

1. CWE NRAs, Action Plan published in February 2007, http://www.creg.info/pdf/Presse/2007/compress12022007uk.pdf

2. Joint study by CEPs, MAVIR, PSE and SEPs regarding the issue of 'Unplanned flows in the CEE region in relation to the common market area Germany-Austria, published in January 2013, http://www.sepsas.eu/seps/Dokumenty/Aktuality/2013/01/30/German_Austria_MA_Study_PSE_CEPS_MAVIR_SEPS_30_01_2013.pdf

3. Marien et al., IEEE Paper, 'Importance of Design Parameters on Flowbased Market Coupling Implementation', published on May 27, 2013, http://ieeexplore.ieee.org/document/6607298/

4. CWE TSOs, 2014, Documentation of the CWE FB MC solution as basis for the formal approval-request, http://jao.eu/support/resourcecenter/ (updated in 2017)

5. CREG decision 1410 on the implementation of the CWE FB MC in the CWE region (French), including the Position Paper of CWE NRAs on Flow-Based Market Coupling (in English), published on April 23, 2015, http://www.creg.info/pdf/Decisions/B1410FR.pdf

6. Joint Allocation Office, launched on June 24, 2015, Daily publication of data through the JAO utility tool for FBMC, www.jao.eu/marketdata/implicitallocation

7. CREG Study on "the price spikes observed on the Belgian day-ahead spot exchange Belpex on 22 September and 16 October 2015", published on March 24, 2016, http://www.creg.be/nl/publicaties/studie-f160324-cdc-1520

8. Swedish Energy Markets Inspectorate, Capacity limitations between the Nordic countries and Germany, published in December 2015, http://ei.se/Documents/Publikationer/rapporter_och_pm/Rapporter%202015/Ei_R2015_12.pdf

9. ACER/CEER Annual Report on the Results of Monitoring the Internal Electricity Markets, published on November 9, 2016, https://www.ceer.eu/documents/104400/-/-/78e02a2c-af64-501b-3b78-2f0e52b66a91

10. ACER Recommendation on the Common Capacity Calculation and Redispatching and Countertrading Cost Sharing methodologies, published on November 11, 2016, http://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Recommendations/ACER%20Recommendation%2002-2016.pdf

11. CWE TSOs presentation at the CWE Consultative Group meeting, held on February 28, 2017, Brussels

12. Swedish Energy Markets Inspectorate, Reduced capacity on German-Nordic interconnectors, Regulatory framework and socioeconomic effects on the European electricity market, 2017, http://ei.se/Documents/Nyheter/Nyheter%202017/Rapport_EI_NVE_Reduced%20interconnector%20capacity_170616.pdf

13. CREG note, 'Review of CWE day-ahead market results during May 1 2017', published on July 17, 2017, http://www.creg.be/sites/default/files/assets/Publications/Notes/Z1655EN.pdf

7. STORYLINE

2001 ETSO (the predecessor of ENTSO-E, *i.e.* the member organization of all European transmission system operators) publishes its guidelines regarding methodologies for the calculation of available transmission capacities (ATC) for cross-border interconnections. These methodologies are, to this day, still being applied by some TSOs for the calculation of long-term available interconnection capacities.

2005 The Belgian, Dutch, French, Luxembourg and German governments found the Pentalateral Energy Forum (PLEF). This Forum is established to, among others, optimize and harmonize the methodologies applied for the calculation and allocation of cross-border interconnection capacities between the different countries involved. The PLEF consists of representatives of Ministries, Regulators, TSOs, Power Exchanges and the Market Parties Platform (producers).

2007 CWE regulators publish, in **February**, their action plan to strengthen the integration of their power markets. This action plan foresees the development and implementation of a *flow-based* market coupling for the CWE bidding zones. In **June**, all Ministers of the CWE countries sign, jointly with the representatives of TSOs, power exchanges, regulators and producers, a Memorandum of Understanding to develop and implement the flow-based market coupling for the day-ahead timeframe. Both agreements included the study of scenarios with adequate bidding zones. In September 2007, during the annual CWE stakeholder's forum, all CWE NRAs made common presentations related to the Flow Based market coupling and to the calculation of (transmission) capacities where the risk of discrimination due to the prioritization of internal exchanges and the need for the examination by TSOs of configurations with more bidding zones is clearly indicated (to all stakeholders, and to the TSOs in particular).

2008 In **June**, CWE TSOs and power exchanges, through the Joint Steering Committee, unilaterally announce the implementation of an ATC-based approach to couple the markets in the CWE region. CREG reacted by a letter to this unilateral decision.

2009 In **October**, CREG made a presentation at the PLEF meeting highlighting the impact of loop-flows (situation with 2000 MW of loop-flows without cross-border exchanges were observed) and proposing the recourse to minimum capacities.

2010 Elia develops and submits a proposal for a new general model for the calculation of the total transfer capacity and the transmission reliability margin. In addition, Elia submits a proposal for the calculation of day-ahead transmission capacity to CREG, for approval in the scope of the CWE MC. In **October**, CREG decides not to approve the proposal from Elia, due to the fact that it considers the proposal not compliant with the European legislation related to the non-discrimination of domestic and cross-zonal exchanges. In light of other benefits of increased market coupling in the CWE region, CREG decides however to allow the implementation of the proposed methodology. During the meeting held in Brussel the 17 of **September**, it is announced that the coupling of the CWE and of the Nordic region will go-live the 9 November 2010. During this meeting, as an answer to CREG request for

minimum capacities, CWE NRAs agreed to ask to the TSOs a study on the impact of the size of the bidding zones on the implementation of a Flow-based market coupling in the region.

2012 In **March**, Central East European (CEE) TSOs publish a position paper on Bidding Zones Definitions as a response to a study commissioned by BnetzA and authored by Frontier Economics and Consentec: "Relevance of established national bidding areas for European power market integration – an approach to welfare oriented evaluation", stating that unscheduled flows (resulting from internal commercial transactions between Northern and Southern Germany and between Germany and Austria) are significantly affecting both power flows and security conditions in the neighbouring countries, endanger the network security of neighbouring systems and limit their cross-border trade capacity. Their analysis concludes that significant unplanned flows are avoidable, since the only reason for significant unplanned flows is a bad market design and incorrect definition (size) of bidding zones. Already in 2012, CEE TSOs state that "Implementation of Flow-Based allocation (FBA) mechanism under current bidding zone delimitation does not efficiently tackle the issue of unplanned flows as this will not allow for the internal transactions within large bidding zones to be controlled by this mechanism. CEE TSOs affirm that the Frontier/Consentec study is incorrect when it discusses the issue of loop flows and especially the effectiveness of market design measures in dealing with these flows. A correct definition of bidding areas is a crucial element of market design to ensure economically efficient and secure operation of the interconnected power system, as well as correct pricing of capacities.

2013 Since January 2013, more than two years before the go-live of the flow-based market coupling, simulations of the functioning of the flow-based proposed mechanisms were performed on the basis of operational data used for the NTC calculations. These simulations, called "parallel runs", were used for the determination of reliability of the flow-based calculation process and of the performance of the flow-based method compared to the NTC approach. These simulations demonstrated the benefits of the implementation of a flow-based mechanism. The expected increase of the socio-economic welfare due to the implementation of a flow-based market coupling in the CWE region was estimated at 132,23 M€ (for 355 simulated days) for the 2014 year (§ 161 of CREG decision 1410 on flow-based proposal). Note that these calculations were performed on a given set of BCs selected "freely" by the TSOs used for the two years of the duration of the parallel runs. This increase of the global welfare, combined with a better price convergence, constituted the main reasons for CREG conditional approval of the proposed method. In **August**, the CWE FBMC Project developed the first FBMC "approval package", containing a description of the flow-based market coupling methodology.

2014 The CWE FBMC Project starts running daily "internal parallel runs", starting from **February**. In **May**, the CWE FBMC Project submits a second approval package. CWE regulators consider the package to be incomplete and continue the development and discussions with the CWE FBMC Project partners. In **June**, CWE regulators organize a public consultation on the FBMC. In **August**, the CWE FBMC Project submits a third, adapted version of the approval package. Till **March 2015**, the partners of the project continued modifying and adding to the approval package, in cooperation with CWE regulators. At the end of 2014, project partners addressed issues related to the functioning of FBMC in times of scarcity combined with flow factor competition issues and the adequacy patch is proposed (with FB, imports for a country may be equal to zero even if the ask price is 3000€).

2015 In **February**, Elia submitted for approval the methodology for the day-ahead flow-based market coupling of the CWE markets, to CREG. In **April**, CREG considered the proposal to be not compliant with Regulation 714/2009, in specific with the articles related to non-discrimination of internal versus external exchanges. However, in light of the announced benefits of the proposed flow-based market coupling implementation, CREG decided (Decision 1410) to approve the proposal conditionally on the implementation of a number of improvement proposals, by CREG and other CWE regulators. CWE NRAs formalized their common position in a "Position Paper of CWE NRAs on Flow-based Market Coupling", where the different improvements linked to the implementation of FB were

indicated. These improvements concerned mainly: the adequacy patch, the monitoring of the flow-factor competition issue, the (unjustified) external constraints, a reduction of the FRM, the justification/proposal of a better CBCO selection rule and the improvements of GSK (transparency, harmonization, and hourly update). Note that at that time, Entso-E study on the review of the bidding zones was ongoing and no additional, specific request was made for that reason in the Position Paper. In **May**, the CWE FBMC Project operates the first successful business day of day-ahead flow-based market coupling. A few weeks after go-live, in **July**, Amprion added several new internal critical network elements. This action was not immediately clearly communicated to the NRAs and to the market. In **September and October** 2015, price spikes were observed in the Belgian market. On the basis of CREG study 1520 on this issue published in March 2016, the reasons of these price spikes were attributed to non-competitive flows, amongst which loop-flows which have a priority access to the transmission capacity, regardless of the scarcity of this capacity or the willingness to pay for it. This study is published on CREG webpage in English.

2016 **November** prices spikes and limitation of import capacities of France and Belgium were observed. After a quick analysis, it appears gradually that these limitations should have their origin in critical branches inside the Amprion system. **11 November: ACER** published his Recommendation 02/2016 on the "Common Capacity Calculation and Re-dispatching and Countertrading Cost Sharing Methodologies". In that recommendation, the principles for the treatment of internal congestions is recalled, indicating clearly that limitations on internal network elements should not be considered in the cross-zonal capacity calculation methods (so no internal critical branches), together with the principle for the treatment of loop flows which should not reduce the capacity of cross-zonal network elements and the principle on the sharing of re-dispatching costs based on the "polluter pays principle" where the unscheduled flows should be identified as the polluter. This recommendation was supported by a large majority of NRAs. **December** 15: CREG requested to BNetzA a neutralization of the impact of the internal critical branches for the beginning of January 2017 when the economic activity will restart. In parallel, CREG sent a letter to ELIA requesting a simulation of the impact of the German internal lines and of the loop-flows on the volumes and prices observed on Belpex in November 2016.

2017 **January**: At the end of the month, as requested by CREG, ELIA delivered the results of the requested simulations. Based on quick CREG calculation, the huge impact of Amprion internal critical branches was confirmed.

2017 **February**: The 27th of February CREG transmitted to all CWE NRAs his proposal for the selection of critical network elements which should be in line with ACER Recommendation (the corresponding slide show was sent the 17th of March). The 28th of February, the huge impact of the critical branches added after the go live on the expected benefits of the implementation of the CWE FB MC can be found in the last slides of a presentation given by CWE TSOs at a stakeholder forum called the CWE Consultative Group meeting.

2017 **March:** In an CWE TSOs & NRAs expert meeting, CWE TSOs delivered a common presentation on the results of the simulation made at CREG request. This presentation confirmed the important impact of these lines on the welfare, provides an estimation of re-dispatching costs increase linked to the removal of these internal lines from the FB mechanism and indicated the risk that the operational feasibility of the proposed measure cannot be guaranteed due to the lack of re-dispatching resources. In March, CREG distributed his proposal for an improved CBCO selection rule which should be in line with ACER recommendation. This proposal was presented and discussed between CWE and CORE NRAs, and received a large support. The proposal was transferred to CORE TSOs as input or indication for meeting ACER recommendation in the proposal CORE TSOs has to made for the implementation of a flow-based capacity calculation methodology.

2017 **June**: CORE (CWE + CEE) TSOs launch a public consultation on the proposal of common capacity calculation methodology for the day-ahead and intraday market timeframe for the CORE region. **July**

EFET, Eurelectric, Nordenergi and the CWE Market Parties Platform summarize their main findings in a common position paper, indicating that the proposal does not seem to comply with the requirements set out in the CACM Regulation. They explicitly raise concerns on the CBCO-selection proposal: "The possibility to select internal lines or transformers as critical network element is questionable as this basically means that a possible congestion on such internal line will be managed by limiting cross-zonal trade. It seems discriminating cross-zonal trade towards trade within a zone. (….). Such practice is in conflict with Regulation 714/2009 and Article 1.7 of the CACM Guidelines (…)."**2017 September**: CORE TSOs deliver a proposal for CORE DA & ID FBMC with no details on a revised CBCO-proposal, while such a thorough revision has been explicitly requested and discussed upfront with NRAs.

2017 October: CWE TSOs communicate CWE NRAs to not study or implement a revised CBCO-selection method before March 2018 in the CWE region. In their common position paper of 2015, CWE NRAs had requested an improved CBCO-selection method before September 2017.

2017 November: At a high-level CWE NRA meeting held in Paris, CWE NRAs did not reach an unanimous position on the removal of the 20 most impacting and highly preloaded internal critical branches as a short-term measure for implementation in winter 2017-2018, given that no improved CBCO selection method had yet been proposed by TSOs. These internal lines, which are in contradiction with the legal framework (TSOs may not "push" internal congestions at the border), have a strong negative impact on the results of the FBMC, especially at winter time. The majority of NRAs present insisted on the need of a regionally coordinated approach for these issues.

2017 December: At a high-level CWE NRA meeting with DG Energy, CWE national regulators negotiated for a second time upon short and medium term measures to remediate the current situation. If the measures, proposed by CREG and other NRAs, will be implemented, CREG expects a significant improvement of the functioning of CWE FBMC. The absolute impact of the improvements will depend on the threshold and targets agreed upon.

For the Commission for Electricity and Gas Regulation:

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Director

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President of the Executive Committee

ANNEX 1 CREG PROPOSAL FOR THE ADAPTATION OF THE CBCO SELECTION METHOD AND THE BASE CASE DEFINITION IN THE CWE FLOW BASED MARKET COUPLING